A STUDY TO IDENTIFY

SELECTED VARIABLES ASSOCIATED WITH LENGTH OF STAY OF OUTLIER DIAGNOSIS RELATED GROUPS AT BROOKE ARMY MEDICAL CENTER

A Graduate Management Project

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Stepwise multiple regression analysis was used to identify 14 variables associated with LOS of 7 DRGs. DRGs 125, 143, 132, 122, 014, and 172 were selected for analysis. Variables found to be associated with LOS were: day of admission, day of discharge, preoperative days, number of diagnoses, number of procedures, provider, source of admission, number of consultations, number of laboratory procedures, social work discharge planning, nursing service discharge planning, and number of admissions.

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I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot express it in numbers, your knowledge is of a meagre [sic] and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to a state of *Science*, whatever the matter may be.

Lord Kelvin (1824-1907)

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My wife, M'Liss supported and assisted me every inch of the way. My daughter Katherine and my son Judson have had a part-time father for three years.

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INTRODUCTION

Background

Diagnostic Related Groups (DRGs) were developed at Yale University by Robert Fetter and John D. Thompson to improve the efficiency of hospitals.[1] These Yale investigators applied Fetter's specialization in industrial management and cost accounting techniques to develop 467 classes of patients and characterized hospital output as what was later known to be DRGs.[2,3] The significance of this initial research was that hospital inputs were linked to measurable economic outputs.

Initially, DRGs were intended to be used as a hospital management control system. However, few hospitals responded to DRGs to improve their efficiency. The Yale concept then evolved into a reimbursement system when New Jersey, and later, the federal government assessed a fixed price to each DRG.[4]

The National Defense Authorization Act for Fiscal Year 1987 directed the Department of Defense to use DRGs as the principal performance measurement for allocating resources to medical treatment facilities.[5] To enact the legislative intent of the Authorization Act, the Assistant Secretary of Defense (Health Affairs) has planned a phased implementation of DRGs beginning FY 1989.[6] This is a policy that is reflective of the Federal Government's previous initiative to move Medicare to a prospective payment system using the DRG as the performance measurement unit. The changes that the DRG brought to the civilian sector caused a fundamental shift of financial incentives surrounding civilian health care delivery. Similar changes in incentives are imminent for the military health care delivery system.

The change to a new system, with new incentives for performance, presents challenges and opportunities for the leaders of US Army health care institutions. To contend with the challenge, efficient employment of all resources must go hand-in-hand with the application of quality in health care delivery. Like any other economic entity, health care organizations function to produce a good or service. Health care organizations exist for the purpose of transforming resources into health services to produce improved health status. Countless intermediate transformations may occur before a final output is achieved. A normal function of organizations is to manage production and quality control of their output. Health care organizations have several programs for the management of production and quality control.

Quality Assurance (QA) "integrates programs in an attempt to protect or raise the level of health care services."[7] The implication of effective QA programs are better health service outputs. For the purposes of this paper, a "health service output" is defined as the satisfactory health status of a patient discharged under one of 472 DRG categories.

Utilization review (UR) is the analysis and measurement of the appropriate and efficient use of resources for health services delivery. UR focuses on the quality and quantity of inputs into the health service output. A health service input is defined as physician services, nursing services, and ancillary services, provided under physician management at BAMC. Utilization management is deciding and acting upon UR indicators.

Patient length of stay (LOS) is frequently used as an indicator for UR. LOS is easily measured and is normally a data element maintained by hospitals. U.S. Army hospitals report LOS for each patient to the Patient Administration Systems and Biostatistics Activity of the Health Services Command.

LOS has implications for QA, UR, and mission readiness. Excessive LOS prolongs the patient's exposure to hospital endemic infections, increases the risks of unnecessary procedures, and consequently increases the risk of an iatrogenic disease. On the other hand, decreased LOS improves the military readiness posture if healthy active duty patients are returned to duty sooner. Discharge planning functions to insure that a patient's LOS in an acute care facility is only as long as is appropriate. Finally, since there is a historical linkage between LOS and cost of care[8], management of LOS should be a significant component of a utilization management program. UR and management of the variables which contribute to LOS could be an effective approach toward management of LOS.

Research Problem

To identify those selected variables which are associated with the length of stay (LOS) of selected diagnosis related groups (DRGs), produced by the Department of Medicine at Brooke Army Medical Center, Fort Sam Houston, Texas.

Research Objectives

1. Review the literature for variables that are associated with LOS.
2. Select variables which are possibly associated with LOS.
3. Develop a regression model that identifies variables which are associated with LOS.
4. Acquire or download data from existing information systems to develop a data base. Perform all data base management and model base management on a MS DOS based personal computer.
5. Test the variables with the regression model and perform a statistical analysis to identify those variables having a statistically significant association with increased LOS. Estimate the contribution each significant variable makes on LOS.
6. Identify those variables that can be directly or indirectly influenced by management.
7. Make recommendations for better utilization management.

Criteria

Final regression models demonstrate significance at the alpha 0.05 confidence level by an F test. Significant variables demonstrate significance by a partial F test.

Assumptions

1. The clinical outcome of cases within like DRGs are within clinically acceptable ranges of quality.
2. Patients are discharged with appropriate discharge plans.
3. Information recorded in the health record and the Inpatient Data System (IPDS) is accurate and complete.
4. The sample size collected for the study is representative of the population.

Limitations

1. Data used for research was limited to that which was acquired through the IPDS data base and the BAMC inpatient records section.
2. Findings are limited to Brooke Army Medical Center and to those clinical areas responsible for production of the selected DRGs.
3. The size of the population of cases within the mix of DRGs studied restricts the power of conclusions that may be drawn from statistical models.
4. This study determined an association between LOS and certain variables, but its nonexperimental design prevented it from determining the effect of other variables on LOS.

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5. Individual cases within DRGs were not controlled for severity of illness or acuity.

Review of the Literature

Authors of both the popular literature[9] and the health service management literature[10,11] considered DRGs as both an incentive and a management instrument to gain control of the escalating costs in health services. They believed the end of Medicare's retrospective cost pass-through would curtail unnecessary use of resources, and transform hospitals into more efficient organizations. The new economic rules would change the organizational behavior of hospitals and cause "the waning of professional dominance" in health services.

However, as Perrow had described much earlier, hospitals are not simple organizations.[12] Economists are now bemoaning the fact that despite the economic logic of the Prospective Payment System, the costs of health services continue to rise and the only prevailing change is declining LOS.[13]

Herzlinger criticizes the American health care industry for failing to establish fundamental management control systems, despite five years of experience with DRGs.[14] She found few health care organization with effective cost-accounting systems for managerial decision making. Herzlinger also found indifferent and often careless managerial philosophies within many health care organizations. She finds many health care leaders ignorant, if not contemptuous of the practice of management.

Herzlinger concludes that decentralized managerial philosophies without managerial information systems can equate to institutions operating like rudderless ships.

Reinhardt suggests that many hospital administrators falsely believe a reduction in a marginal day of stay will result in a reduction of an average day of costs. He cites an example of this "Fallacy of Composition" in the Grace Commission report on cost reduction in the Veterans Administration (VA). The Commission calculated a cost savings by multiplying the reduction in bed-days by a cost factor per VA bed-day. The fallacy of this calculation is the use of a cost factor derived from the average cost for all patient days. The composition of the reduction are all marginal bed-days. Since the last days of an inpatient visit are usually associated with less cost than average cost, the Grace Commission's calculation overstates the cost savings. Mr. Reinhardt is convinced that hospital administrators are obsessed with LOS statistics and the "obsession with the ALOS [average length of stay] is driven by a Fallacy of Composition."[15]

Following Reinhardt's line of logic, one might conclude that the dramatic reduction of ALOS in hospitals since the introduction of the Prospective Payment System was the result of false economic theory. Reinhardt implies that hospitals are run by administrators who are deceived into a "fallacy as they respond to the economic incentives in Medicare's Prospective payment system."

Whiner, et al. suggest otherwise.[16] From the perspective of organizational theory, they conclude that a reduction in LOS was the hospital administrators' path of least resistance in cost control. Since power rests with those who contend with the most significant uncertainty,[17] physicians still dominate because of the medical contingency. Administrators take the path of least resistance only because clinicians often consider the marginal hospital day to be of little clinical value and can be influenced for an earlier discharge plan.

Payne suggests that UR efforts should target selected DRGs with high rates of inappropriate days or inappropriate admissions. She found nine medical DRGs that had significant differences between appropriate and inappropriate days of stay.[18] The medical DRGs Payne found to have significantly different LOSs are shown in Table 1.

Table I DRG Outliers, Payne (1987b)

DRG 014	Specific cerebrovascular disorders except transient ischemic attacks
DRG 024	Seizure and headache (age >69 and/or comorbidities or complications
DRG 032	Respiratory neoplasms
DRG 039	Simple pneumonia and pleurisy(age >69 and/or comorbidities or complications
DRG 040	Angina pectoris
DRG 143	Chest pain
DRG 182	Esophagitis, gastroenteritis, and miscellaneous digestive disorders (age >69 and/or comorbidities
DRG 395	Red blood cell disorders (age >17)
DRG 403	Lymphoma or leukemia (age >69 and/or comorbities or complications

Frequently, patients inappropriately remain in the hospital when they require a lower-level of health service. The repercussion is longer LOS if transition to a skilled nursing facility is not available or is not planned. Payne reports that as much as 12-14% of all inappropriate days of inpatient care can be attributed to environmental factors such as the non-availability of home health care or skilled nursing homes.[19]

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Variables which contribute to length of stay are widely researched and discussed in the literature. Marchette and Holloman developed a "conceptual framework of length of stay" proposing relationships between LOS and numerous variables including the DRG.[20] The primary thrust of their research was to determine the magnitude of the relationship between LOS and various factors surrounding discharge planning. They found a strong relationship between LOS and discharge planning. Both the content of discharge planning and the timing of the plan seemed to be related to how soon a patient was released from the hospital. Age had a positive correlation with LOS, however, they found no direct relationship between gender, the day of admission, or day of discharge and LOS. Marchette's and Holloman's model was adequate to predict 21% of the variation in the length of stay for the patients they studied.

Several researchers have concluded that a significant amount of the variability in the use of resources is due to individual physician practice patterns.[21] McMahon and Newbold further conclude that physician practice patterns are more significant in the explanation of LOS than the severity of illness.[22] Borchardt attributed 82% of all inappropriate days to the provider.[23] Restuccia and Kreger attributed 72% to providers.[24] However, Weiner reports that administrators are frustrated in their efforts to use physician profile data because patient severity is often not evenly distributed among physicians.[25]

It was suggested DRGs alone do not account for a sufficient amount of the variation in LOS or resource usage.[26] Patients assigned to the same DRG could easily have different illness severity and different health service demands. Referral patterns can confound provider profiles and different facilities may have a more severely ill patient population.

Thorpe examined several factors that seem to account for elevated costs in inner New York City hospitals. He found that the source of admission, i.e. the emergency room was a significant indicator for higher costs. He hypothesized that the population of patients admitted through the emergency room had a greater severity of illness. Using multiple regression techniques and holding DRG case mix constant, he found emergency room admissions to transfer greater costs to hospitals. Thus, it follows that hospitals with a higher case mix admitted through the emergency room would also have higher costs not reimbursed by a DRG reimbursement mechanism.[27]

The source of admission, intensity of illness, association is related to a much earlier criticism by Roemer of ambulatory care policy.[28] Roemer believed that increasing copayments for ambulatory care was "penny wise and pound foolish" because the policy encourages lower-income patients to delay seeking medical care until a more severe stage of illness hospitalization. Roemer's theory is connected to Thorpes' source of admission hypothesis because low-income patients frequently seek the emergency rooms for treatment. Both Roemer and Thorpe have something to say to the military hospital administrator who has an access problem answered by only the MEDDAC or MEDCEN emergency room. If these two scholars are correct, then the military administrator could expect to see longer LOS for patients admitted from the emergency room when the DRG case mix is controlled.

Thorpe found that teaching status was the single most important cost component in urban hospitals among the factors of case mix, wage rates, and increased service intensity caused by non-price competition. Two possible reasons for his findings are: 1) greater use of ancillary services by residents and interns learning their profession, and 2) a greater severity of illness in the patient population of teaching hospitals.

To account for the variation in the severity among patients several methodologies have been developed to measure individual patient acuity. Reider and Kay studied the relationship between the patient classification system used by the Workload Management System for Nursing (WMSN) and LOS for selected DRGs. They found the maximum values of patient classification could explain a significant portion of the variance in LOS for most DRGs they examined. Their results also indicated that the maximum value for classification could also predict LOS.[29]

Morreale found that the independent variable, PROVIDER, could explain a statistically significant amount of the variation in LOS in nine of ten DRGs sampled at a USAF hospital. She also found that substantial variability could be explained by the number of operative procedures coded for a patient's stay. Beneficiary status was found to be significant in only one DRG grouping in the USAF study.[30]

Kelley, Weng, and Watson investigated the effect of clinical consultation on LOS. Using Blue Cross and Blue Shield of Michigan historical files, they found that 30% of medical inpatients received one or more consults. They calculated the difference in LOS between users and non-users on consultation services amounted to 3.76 days in 1976.[31]

The relationship between LOS and the cost per case has also been investigated. Lave and Leinhardt found that increases in LOS cause a decrease in the cost per patient day but increase the cost per case output. They developed regression equations that accounted for 45% of the variation in the average daily cost per case. They also developed a model that accounted for 43% of the variation in LOS. However, one of the independent variables in their equation was the patient's primary diagnosis which accounted for 27% of the variation.[32] Analysis of cost using DRGs to control for case mix would be more sensitive than the methods used by Lave and Leinhardt. However, Weiner et al. found that many administrators did not have cost data available for analysis.[33]

Other variables Lave et al. used were the number of surgical procedures, tests, the number of other diagnoses, the patient's admission status, discharge status, and day of the week admitted.

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Table II Literature Summary

Study	Significant Variables
Marchette et al.	Discharge Planning, Age
Thorpe	Source of Admission
McClure	Provider
McMahon et al.	Provider
Morreale	Provider, No. Procedures
Borchardt	Provider
Restuccia et al.	Provider
Payne	Provider
Kelley et al.	Consultations
Lave et al.	No. of Procedures, Day of Admission
Kay et al.	Severity of Illness

Previous work on variables significantly associated with LOS served as a starting point for variable selection and added to the reliability of results. The availability of coded fields from the IPDS and the inpatient health record provided a pool of variables which were comparable to some of the variables found in the literature. Table II contains a summary of the results found in the literature review.

None of the researchers in this review built models that could account for more than 45% of the variability in LOS. While it was not an objective of this research to exceed previous work in LOS variance explanation, r^2 values of 0.45 or greater could serve as a bench mark for model reasonability.

The U.S. Army Patient Administration Systems and Biostatistics Activity (PASBA) of the Health Services Command published case mix studies using data from the IPDS. Case data for the IPDS is derived from the Inpatient Record Cover Sheet DA Form 3647. Using FY 1987 data, PASBA compared LOS by DRG for significant differences between BAMC and its peer group hospitals. BAMC's peer group is Walter Reed Army Medical Center, Fitzsimmons Army Medical Center, and Letterman Army Medical Center. Table III is a listing of the DRG outliers applicable to the Department of Medicine.[34]

Table III PASBA Case Mix Study

DRG	Description
LONG STAY OUTLIERS	
DRG 125	CIRCULATORY DISORDERS EXC AMI, W CARD CATH W/O COMPLEX DIAG
DRG 143	CHEST PAIN
DRG 132	ATHEROSCLEROSIS AGE >69 AND/OR CC
DRG 410	CHEMOTHERAPY
DRG 395	RED BLOOD CELL DISORDERS AGE >17
DRG 122	CIRCULATORY DISORDERS WITH AMI W.O. C.V. COMP
SHORT STAY OUTLIERS	
DRG 182	ESOPHAGITIS, GASTROENT & MISC DIG DISOR AGE >69
DRG 014	SPECIFIC CEREBROVAS. DISORD EX. TIA
DRG 097	BRONCHITIS & ASTHMA
DRG 461	O.R. PROC WITH DIAGNOSIS OF OTHER CONTACT WITH HLTH SVC
DRG 172	DIGESTIVE MALIGNANCY AGE >69 &/OR CC

Variable Selection and Data Base Development.

Variables were selected for analysis based on the literature review and access to data. Sources for case data were obtained from the PASBA IPDS data base and the BAMC Patient Administration Division Inpatient Records Section. Table V is a listing of the selected variables and their sources.

Table V Variables Selected for Analysis

Field	Description	Type	Data	Source
LN-LOS	Natural Logarithm LOS	Dependent	Integer	IPDS
SEX	Gender	Indepen.	Binary	IPDS
AGE	Age in Years	Indepen.	Integer	IPDS
BLACK	Race	Control	Binary	IPDS
WHITE	Race	Control	Binary	IPDS
OTHER	Race	Control	Binary	IPDS
MIL	Beneficiary Category	Indepn.	Binary	IPDS
RET	Beneficiary Category	Indepn.	Binary	IPDS
ADP	Beneficiary Category	Indepn.	Binary	IPDS
RDP	Beneficiary Category	Indepn.	Binary	IPDS
SCV	Beneficiary Category	Indepn.	Binary	IPDS
NCV	Beneficiary Category	Indepn.	Binary	IPDS
A-SUN	Admitted on Sunday	Indepn.	Binary	IPDS
A-MON	Admitted on Monday	Indepn.	Binary	IPDS
A-TUE	Admitted on Tuesday	Indepn.	Binary	IPDS
A-WED	Admitted on Wednesday	Indepn.	Binary	IPDS
A-THR	Admitted on Thursday	Indepn.	Binary	IPDS
A-FRI	Admitted on Friday	Indepn.	Binary	IPDS
A-SAT	Admitted on Saturday	Indepn.	Binary	IPDS
D-SUN	Discharged on Sunday	Indepn.	Binary	IPDS
D-MON	Discharged on Monday	Indepn.	Binary	IPDS
D-TUE	Discharged on Tuesday	Indepn.	Binary	IPDS
D-WED	Discharged on Wednesday	Indepn.	Binary	IPDS
D-THR	Discharged on Thursday	Indepn.	Binary	IPDS
D-FRI	Discharged on Friday	Indepn.	Binary	IPDS
D-SAT	Discharged on Saturday	Indepn.	Binary	IPDS
PRE-OP	Pre-Operative Days	Indepn.	Integer	IPDS
DIAG	Number of Diagnosis	Indepn.	Integer	IPDS
PROC	Number of Procedures	Indepn.	Integer	IPDS
XX	Provider	Indepn.	Binary	Record
ZIP	Local Zip Code	Indepn.	Binary	Record
ER	Admitted thru ER	Indepn.	Binary	Record
CON	Number of Consultations	Indepn	Integer	Record
LAB	Number of Lab Slips	Indepn.	Integer	Record
SWDP	Social Worker's Discharge Plan	Indepn.	Binary	Record
NSDP	Nursing Service Discharge Plan	Indepn.	Binary	Record
ADM	Number of Admissions	Indepn.	Integer	Record

PASBA provided ASCII files on 5.25" disks containing information from the IPDS for all FY 1987 BAMC cases of the selected DRGs. The information was sorted by DRG and became the basis for a preliminary data base. The initial data base consisted of the following fields: register number, grade, sex, age, race, social security number, beneficiary category, zipcode, date of disposition, date of admission, bed days at BAMC, total bed days to date, pre-op days, all diagnoses, all operations or procedures.

Case data received from PASBA was recoded and transformed from ASCII files into a format compatible with LOTUS 123. The IPDS codes for sex and beneficiary category were recoded into binary variable codes. The seven IPDS codes for race were recoded into three variable codes WHITE, BLACK, and OTHER. The dates of admission and dates of discharge were converted into variable binary codes reflecting the day of the week of admission or discharge. The number of procedures and diagnoses was counted and recoded into PROC and DIAG respectively. Appendix B contains the source code for data conversions.

Each DRG case set was randomly divided into two sub-sets. The first sub-set became the PASBA data set. The second data set became the basis for the RECORD data set. The PASBA data set was complete after the division. The PASBA data set contained variables from the IPDS data source. The RECORD data set was developed by manual extraction from the inpatient health record.

Data Analysis.

Data analysis consisted of two phases. Phase I was an analysis of the PASBA data set. The purpose of Phase I was to select significant variables from the IPDS data set. The significant IPDS variables for each DRG were then carried over, matched with cases from the RECORD data set, and incorporated into the RECORD data base for

PHASE II analysis. Phase II used the RECORD data set and significant PHASE II variables. The variables became the coefficients (B) of a multiple regression equation expressed as: $Y = B_0 + B_1X_1 + B_2X_2 + B_3X_3 + \ldots B_nX_n + E$

Where Y is the dependent variable LN-LOG, and X_{1-n} are the independent variables.

Statements in Table VI are hypotheses of the effects of the selected independent variables to be tested by stepwise regression analysis.

The overall strategy for selection of significant variables contributing to LOS was selection of the best regression equation using length of stay as the dependent variable. The criteria for selection of the best model was the partial F statistic tested at an alpha level of 0.05. The technique for selecting the best model was stepwise regression using the MICROSTAT Version 4 computer software package.[36] Regression diagnostics included residual analysis to demonstrate model reasonability.

Table VI Null and Alternative Hypothesis

Null Hypotheses

1. Discharge planning does not contribute to LOS.
2. The source of admission doe not contribute to LOS.
3. The provider does not contribute to LOS.
4. The number of procedures does not contribute to LOS.
5. The day of admission does not contribute to LOS.
6. The day of discharge does not contribute to LOS.
7. The number of consultations does not contribute to LOS.
8. The number of ancillary services does not contribute to LOS.

Alternative Hypotheses

1. Discharge planning contributes to LOS.
2. The source of admission contributes to LOS.
3. The provider contributes to LOS.
4. The number of procedures contributes to LOS.
5. The day of admission contributes to LOS.
6. The day of discharge contributes to LOS.
7. The number of consultations contributes to LOS.
8. The number of ancillary services contributes to LOS.

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CHAPTER II

DRG ANALYSIS

Since DRGs were developed using financial and other econometric data, there is some content validity to an assumption that variables which explain the variance in LOS of DRGs may also partially explain the resource input into DRG production. Selection of outlier DRGs for analysis contributes construct validity to the application of the findings for utilization review. Long and shortstay outliers were chosen for analysis to examine both groups for similarities or differences in the variables associated with LOS.

Analysis of a set of cases within any DRG will probably result in specific cases with excessive and unnecessary days of stay.[1] Longstay outlier DRGs are of interest because they are likely to require the investment of more resources to produce the same output.

Shortstay outlier DRGs are of interest because they have a greater potential to have excessive days of stay due to inappropriate admissions. Shortstay outlier DRGs magnify cases having longer lengths of stay due to the effects of delayed ancillary services, discharge planning, and other procedures.

The unnecessary days of stay and inappropriate admissions represent a marginal opportunity cost for BAMC. The BAMC opportunity cost are those bed-days that could have been used to produce a unit or some portion of another unit of output.

There is also an opportunity cost to the beneficiary population represented by those patients who are turned away or wait longer for health services.

Stepwise regression analysis of the sample data sets from each DRG identified 14 independent variables that correlated with the dependent variable LN-LOS and remained in one or more of the Final Models. Table VII is a display of the variables associated with LN-LOS. A discussion of the regression analysis can be found in Appendix C.

Table VII Variables Associated with LN-LOS

Variable	DRG 125	DRG 143	DRG 132	DRG 122	DRG 014	DRG 097	DRG 172
SEX	NO	NO	NO	NO	NO	NO	NO
AGE	NO	NO	NO	NO	NO	NO	NO
BLACK	NO	NO	NO	NO	NO	NO	NO
WHITE	NO	NO	NO	NO	NO	NO	NO
OTHER	NO	NO	NO	NO	NO	NO	NO
MIL	NO	NO	NO	NO	NO	NO	NO
RET	NO	NO	NO	NO	NO	NO	NO
ADP	NO	NO	NO	NO	NO	NO	NO
RDP	NO	NO	NO	NO	NO	NO	NO
SCV	NO	NO	NO	NO	NO	NO	NO
NCV	NO	NO	NO	NO	NO	NO	NO
A-SUN	NO	NO	NO	NO	NO	NO	NO
A-MON	NO	NO	NO	NO	NO	NO	NO
A-TUE	NO	NO	NO	NO	NO	NO	NO
A-WED	NO	NO	NO	NO	NO	NO	NO
A-THR	NO	NO	NO	YES	NO	NO	YES
A-FRI	NO	NO	NO	NO	NO	YES	NO
A-SAT	NO	NO	NO	NO	NO	NO	NO
D-SUN	NO	NO	NO	NO	NO	NO	NO
D-MON	NO	NO	NO	NO	NO	NO	NO
D-TUE	NO	NO	NO	NO	NO	YES	NO
D-WED	NO	NO	NO	NO	NO	NO	NO
D-THR	NO	NO	NO	NO	NO	NO	NO
D-FRI	NO	NO	NO	NO	NO	NO	NO
D-SAT	NO	NO	NO	NO	NO	NO	NO
PRE-OP	YES	YES	NO	YES	YES	NO	NO
DIAG	NO	YES	NO	YES	NO	NO	YES
PROC	YES	NO	YES	NO	NO	NO	YES
PROVIDER	YES	YES	YES	YES	YES	YES	YES
ZIP	NO	NO	NO	NO	YES	NO	NO
ER	NO	YES	NO	NO	YES	NO	NO
CON	NO	YES	YES	YES	YES	YES	NO
LAB	NO	NO	NO	YES	YES	YES	YES
SWDP	NO	NO	NO	YES	YES	YES	NO
NSDP	NO	YES	NO	NO	NO	NO	NO
ADM	NO	NO	NO	YES	NO	NO	NO

The PASBA study used criteria establishing each of the selected DRGs as outliers.[2] Yet, this study fell short of identifying any factors that could have contributed to differentiation in LOS.

The remainder of this chapter is a vertical analysis and discussion by DRG. As each DRG is analyzed, factors contributing to LOS are discussed. Longstay outliers are considered first, then shortstay outliers are examined.

Long Stay Outliers Diagnosis Related Groups

Analysis of DRG 125.

Circulatory disorders except acute myocardial infarction, with cardiac catheterization, without complex diagnosis, is the sixth most frequently occurring DRG at BAMC. PASBA counted 246 dispositions in FY 87, which amounted to 1556 total bed days. DRG 125 is ranked third most frequently occurring diagnostic group within the Department of Medicine. Three diagnoses comprise over 90 percent of all bed days and 88 percent of all dispositions. Atherosclerosis is involved with the vast majority of cases. When the ALOS for all of BAMC dispositions in this group are compared to either CHAMPUS dispositions or peer group dispositions, BAMC ALOS is significantly higher.[2]

Stepwise regression analysis identified six significant variables which explain approximately 83% of the total variation in the LOS for DRG 125. The variables selected by the final model were LAB, PROC, PRE-OP, HD, SA and WB. Table IV of Appendix C is a listing of these variables and their statistics.

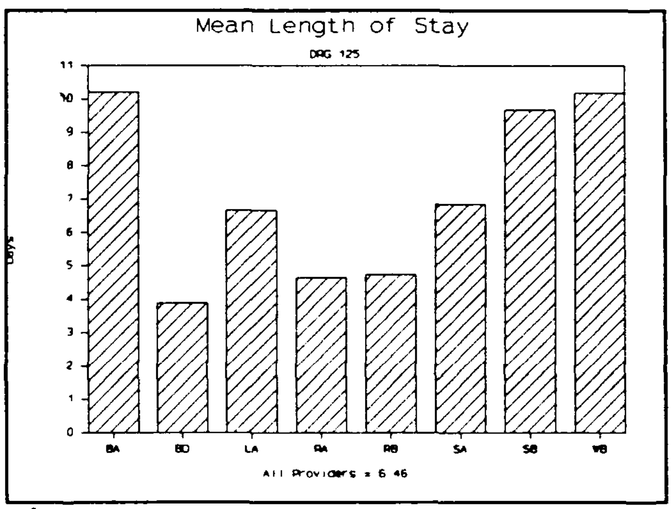

Figure 1 ALOS DRG 125

The mean length of stay for the

sample cases of DRG 125 was 6.46 days. However, mean LOS among providers for DRG 125 varied considerably. Figure 1 shows LOS by physician. BA, LA, SA, SB and WB had mean LOS higher than the mean for all providers. However, conclusions for the regression model must be drawn cautiously. The number of cases were not distributed evenly among all providers and many providers had too few cases to allow any conclusions.

Figure 2 shows the number of cases per physician varies from two cases to twelve cases. Providers with less than two cases are not shown. Of the three provider variables selected by the final model, only SA had a meaningful number of cases. HD had only one case and WB had two cases.

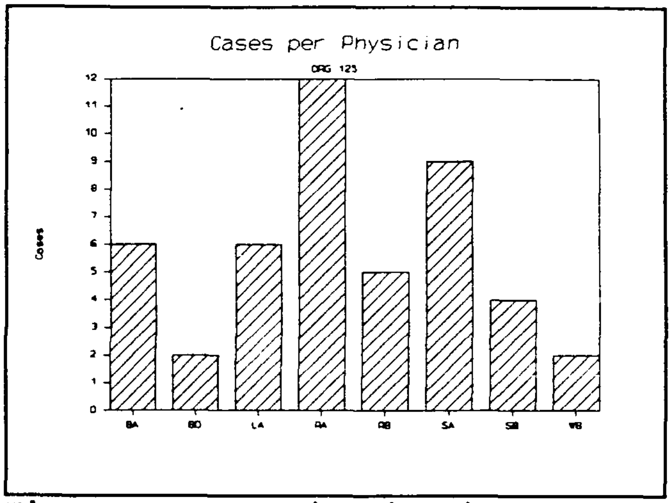

Figure 2 Case Distribution DRG 125

LAB was found to be a significant variable in terms of the magnitude of its partial r^2. Unfortunately, regression analysis does not explain *why* LAB is correlated with LN-LOS. Use of laboratory procedures throughout a patient's stay is probably useful to the attending physician for diagnosis and treatment. Figure 3 depicts the mean number of laboratory reports found in each record of the sample for DRG 125. The mean number of laboratory reports for all providers was 10.68 reports. Three providers; BA, SB, and WB seem to have greater usage of laboratory services than their peers.

BA, SB and WB had longer ALOS for DRG 125 than their peers. When a LOS factor is divided into total laboratory usage per stay, the LOS has a leveling effect upon laboratory usage among providers. Figure 4 shows the mean number of laboratory reports per day at BAMC for the sample of DRG 125.

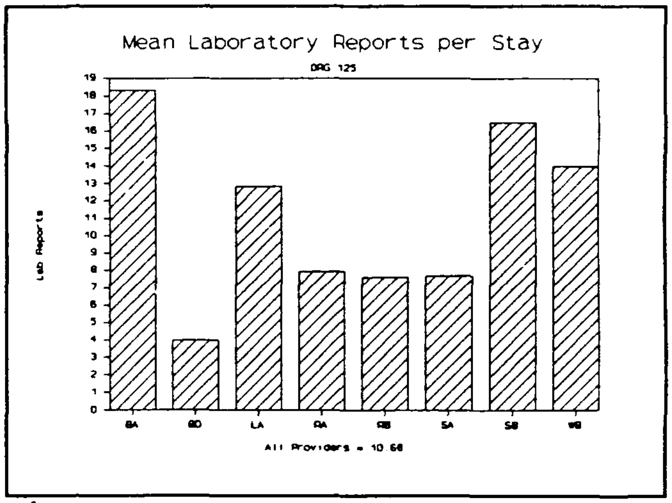

Figure 3 Lab Report DRG 125

Average daily usage rates appear to have less variation among the sample providers. Figures 3 and 4 together with the LAB correlation shown in the regression model indicate moderately consistent laboratory usage among providers for DRG 125.

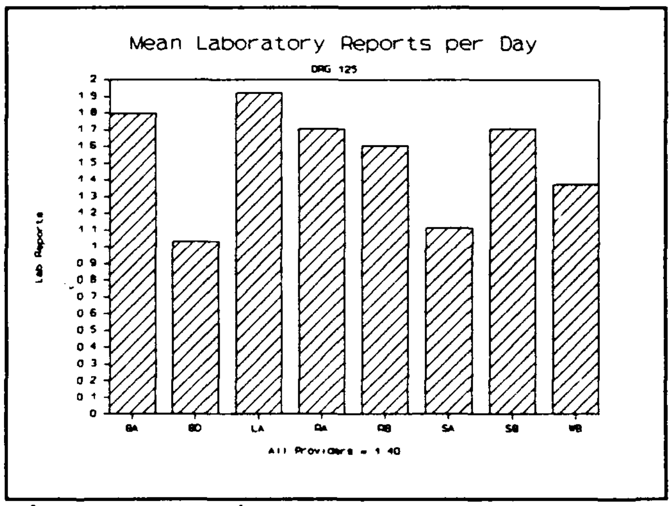

Figure 4 Daily Lab Reports - DRG 125

The partial r^2 for PROC indicated that the number of procedures performed during a stay was the second strongest explanation of variation in LOS in the Final Model. By definition, patients discharged in the category of DRG 125 had at least one procedure - cardiac catheterization. The decision for catheterization is usually made after some type of diagnostic imaging. Ideally, imaging can be done on an outpatient basis. However, many admissions are unplanned. Unplanned admissions are often admitted during a crisis through the ER. A delay in obtaining an imaging procedure could delay the decision and lengthen the patient's stay. The positive correlation coefficient for PROC also indicated that the longer a patient remained as an inpatient, the greater the probability of having other procedures performed. The most frequent procedure, other than cardiac catheterization, was for some type of diagnostic imaging.

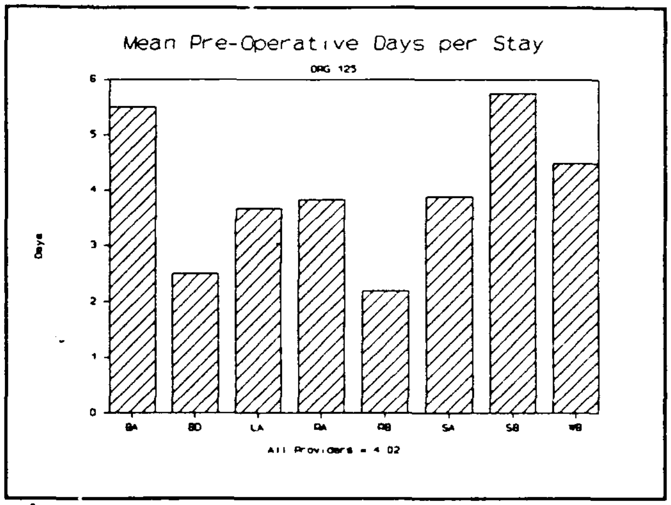

Figure 5 PRE-OP Days - DRG 125

The number of days that patients wait for cardiac catheterization is also predictive of their LOS. Figure 5 depicts the mean number of pre-operative (PREOP) days per stay by physician. The number of PREOP days varies from just under six days to just over two days. Unscheduled admissions for cardiac catheterization can often result in the sickest patients spending the first portion of their stay in an intensive care unit. The typical unscheduled

admission is longer and more costly because of intensive care and pre-catheterization care.

Analysis of DRG 143.

Chest Pain is ranked the seventh most frequently occurring diagnostic group at BAMC. PASBA counted 227 dispositions in FY 87, which amounted to 993 bed days. DRG 143 is the fourth most frequently occurring DRG within the Department of Medicine. When the ALOS for all BAMC dispositions for DRG 143 are compared to those of either CHAMPUS or the medical center peer group, the BAMC ALOS is significantly higher than both.[2]

Stepwise regression analysis identified 13 significant variables which explain approximately 80% of the total variation in the LOS for DRG 143. The variables selected by the Final Model were BA, BB, HA, HD, MA, OA, PB, WB, ER, CON, DIAG, NSDP, and PRE-OP. Table VIII of Appendix C is a listing of these variables and is accompanied by their statistics.

The mean length of stay for the sample cases of DRG 143 was 3.77 days. However, mean LOS among providers for DRG 143 varied considerably. Figure 6 shows LOS by physician. BA, LA, SA, SB and WB had mean LOS higher than the mean for all providers. However, the number

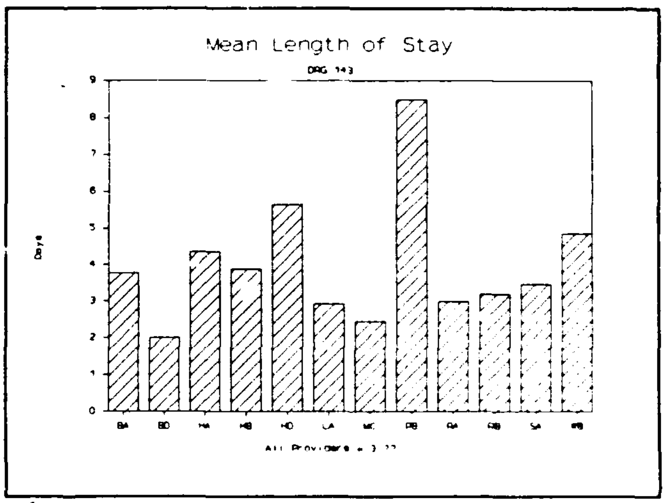

Figure 6 ALOS DRG 143

of cases was not distributed evenly among all providers and many providers had case numbers that were too small to allow conclusions.

Of the eight provider variables selected by the final model, only HA, HD, and WB had more than three cases. While provider PB's mean LOS graphically stands out from other providers in Figure 6, the small number of cases gives little information about PB's case mix or style of practice.

Admission through the emergency room had a positive correlation with length of stay for the chest pain group. Patients admitted through the emergency room stayed 1.3 days longer than patients admitted from other areas in the hospital.

DRG 143 is entirely composed of patients discharged from BAMC with a principal diagnoses of "Observation for Suspected Cardiovascular Disease (ICDM-9-CM V717)." Code V717 diagnoses also represented 25% of the dispositions for DRG 125. The principal difference between the groupings are cardiac catheterization procedures. It was not surprising to find inpatient consultations for patients admitted for chest pain to be correlated with speedier discharges. Presumably, consultations result in decisions which rule out the decision for cardiac catheterization.

The number of diagnoses was significant for a positive correlation with LOS. This finding could be due to the added complexity and acuity of patients with multiple health problems.

Discharge planning by nursing personnel was correlated with a longer length of stay. Patients with more complex home health care needs, medications, and final discharge instructions requiring a nurse's explanation tended to stay longer. It is also possible that the extra time that sicker patients stayed in the hospital allowed more time for nursing personnel to document the health record.

As in DRG 125, the number of pre-operative days was positively correlated with length of stay for DRG 143. Pre-operative days in the case of DRG 143 are composed of days waiting for a major procedure. Diagnostic imaging is the most frequent category of procedures. Imaging is used to rule out the need for surgery or cardiac catheterization. Patients admitted for "Observation for Suspected Cardiovascular Disease" may have a diagnostic requirement which prolongs their LOS due to backlogged procedure schedules. Over 64 percent of all patients undergoing a procedure are discharged within 24 hours of the imaging procedure.

The linkage between DRG 125 and DRG 143 begins with the convergence of the same principal diagnosis, "Observation for Suspected Cardiovascular Disease." Delays in obtaining results from imaging and other ancillary services can delay the decision to discharge home or perform cardiac catheterization.

Analysis of DRG 132.

Atherosclerosis, age greater than 69, and or complications, is the eleventh most frequently occurring DRG at BAMC. PASBA counted 192 dispositions in FY 87, which amounted to 1236 total bed days. DRG 132 is fifth most frequently occurring diagnostic group within the Department of Medicine. Two diagnoses comprise over 97 percent of all bed days and 98 percent of all dispositions for DRG 132. Coronary Atherosclerosis (ICDM-9-CM 4140) is the principal diagnoses for 88 percent of all cases. When the ALOS for all of BAMC dispositions for this group are compared to those of either CHAMPUS or the Peer Group, the BAMC ALOS is significantly higher than both.[2]

Stepwise regression analysis identified two significant variables which explain approximately 52 percent of the total variation in the LOS for DRG 132. The variables selected by the Final Model were PROC and CON. Table XII of Appendix C is a listing of these variables and their statistics.

The mean length of stay for the sample cases of DRG 132 was 6.16 days. The mean LOS among providers varied less than DRGs 125 or 143. DRG 132 had one significant provider variable, NA. However NA represented only one case. Figure 7 is a graphic representation showing LOS by physician. WC stands out with mean LOS higher than the mean for

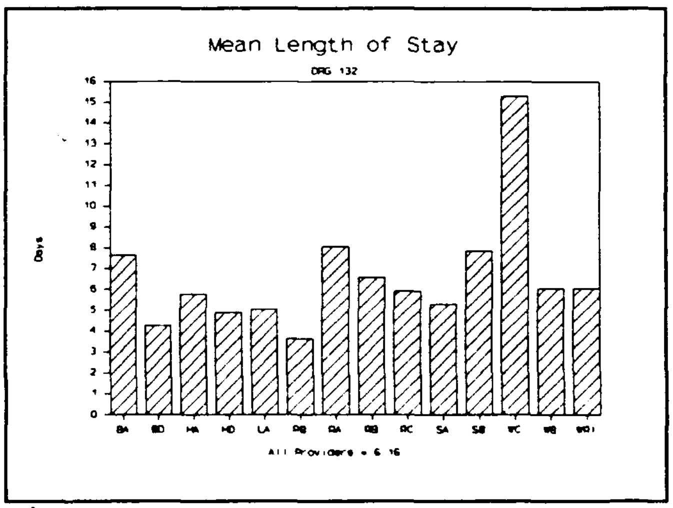

Figure 7 ALOS DRG 132

all providers. However, Figure 8 shows that WC had only two cases. The number of cases was not distributed evenly among all providers and many providers had case numbers that were too small to allow conclusions. Figure 8 shows the number of cases by physician from two cases to seven cases. Providers with less than two cases are not shown.

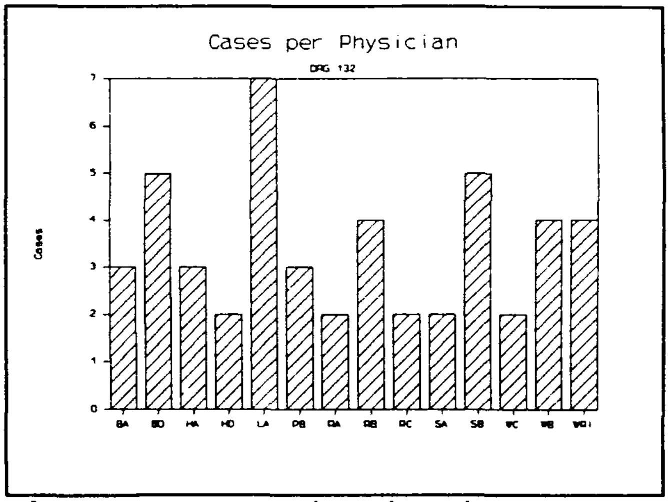

Figure 8 Case Distribution DRG 132

The partial r^2 for PROC indicated that the number of procedures performed during a stay was the strongest explanation of variation in LOS in the Final Model. The procedure most often performed usually involved diagnostic imaging. The most frequent procedure was coded as a hemopoietic radioisotope scan. Forty percent of all scans were scheduled within twenty four hours of discharge. A delay in obtaining an imaging procedure could delay the decision and lengthen the patient's stay. The positive correlation coefficient for PROC also indicated that the longer a patient remained as an in patient, the greater the probability of having other procedures performed. The most frequent procedure other than cardiac catheterization was for diagnostic imaging.

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The number of consultations is positively correlated with LOS and was identified as a significant variable by stepwise regression of the final Phase II Full Model set. Figure 9 is a display of the mean number of consultation reports found in each record, by provider. The relatively high number of consultation reports requested by WC are attributed to one case having a long LOS. Otherwise, the mean number of consultations per stay is relatively low. The mean number of consultations for all cases was 1.5. A critical aspect of the consultation service is timeliness. Consultation requests categorized as routine may not be completed within 24 hours. Consultations with specialists can drive determination of the final diagnosis and treatment plans.

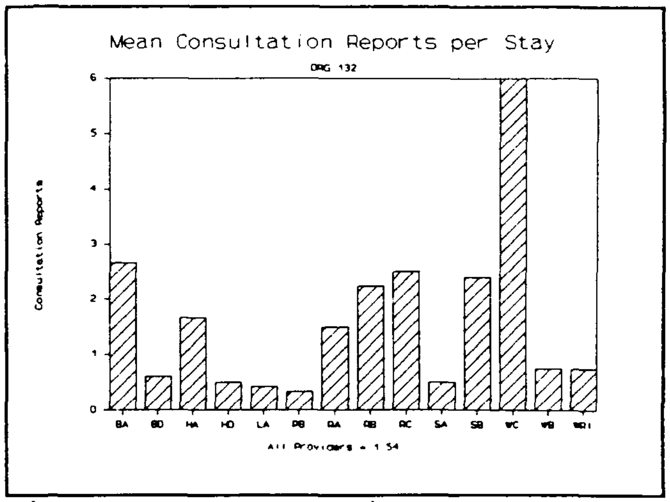

Figure 9 Consultations - DRG 132

Analysis of DRG 122.

Circulatory disorders with acute myocardial infarction, without cardio vascular complications, is the 59th most frequently occurring DRG at BAMC. PASBA counted 65 dispositions in FY 87, which amounted to 924 total bed days. DRG 122 is ranked 19th most frequently occurring diagnostic group within the Department of Medicine. Six diagnoses comprise over 84 percent of all bed days and 89 percent of all dispositions for DRG 122. When the ALOS for all of BAMC dispositions for this group are compared to those of either CHAMPUS or the Peer Group, the BAMC ALOS is significantly higher.[2]

Stepwise regression analysis identified 10 significant variables which explain approximately 81% of the total variation in the LOS for DRG 122. The variables selected by the Final Model were CON, LAB, DIAG, SWDP, ADM, PRE-OP, A-THR, HA, RB, and SA. Table XVI of Appendix C is a listing of these variables and their statistics.

The mean length of stay for the sample cases of DRG 122 was 14.83 days. However, mean LOS among providers for DRG 122 varied considerably. Figure 10 exhibits LOS by physician.

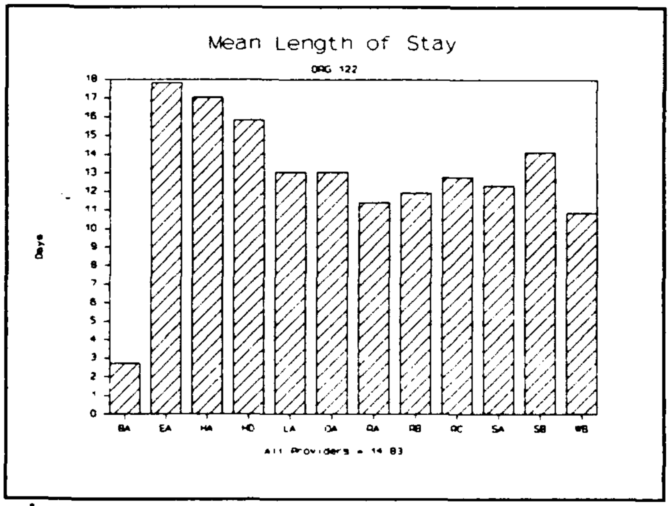

Figure 10 ALOS - DRG 122

HA, SA, and RB had mean LOSs higher than the mean for all providers. The number of cases was not disbursed evenly among all providers and many providers had too few cases for conclusions.

Figure 11 shows the number of cases per physician varies from two cases to ten cases. Providers with less than two cases are not shown. Of the three provider variables selected by the final model, only RB and HA had a meaningful number of cases. SA had only three cases.

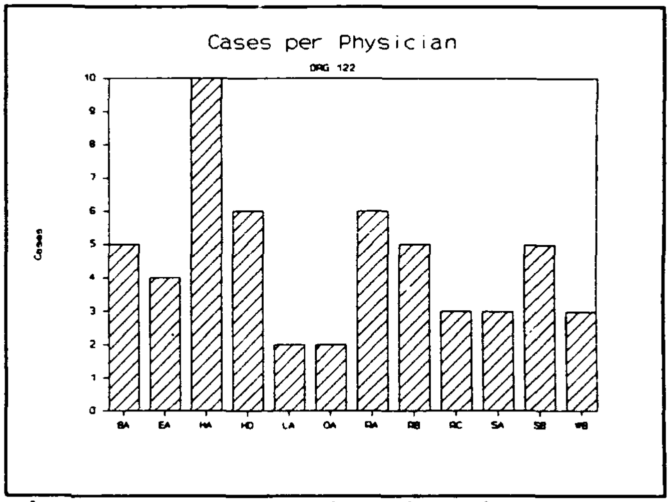

Figure 11 Case Distribution - DRG 122

Stepwise regression analysis detected LAB as a significant variable. Laboratory procedures are presumably useful to the attending physician for diagnosis and treatment. Figure 12 depicts the mean number of laboratory reports found in each record of the sample for DRG 122. The mean number of laboratory reports for all providers was 30.07 reports. EA appears to

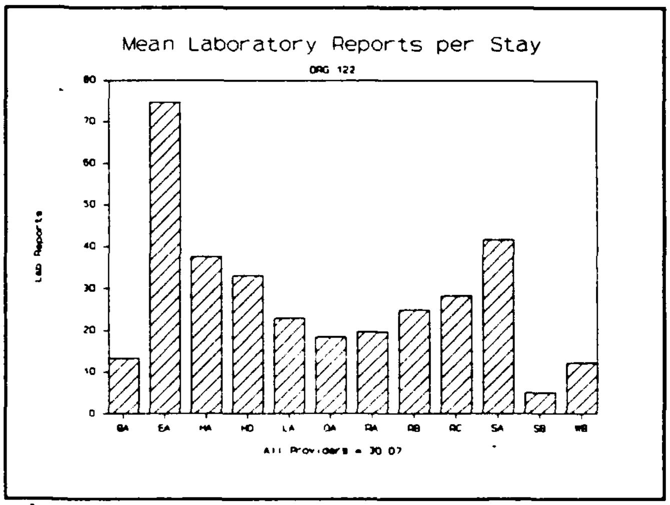

Figure 12 Lab Reports DRG 122

have greater usage of laboratory services than his or her peers.

When a LOS factor is divided into total laboratory usage per stay, laboratory usage per day is a similar profile for all providers except for provider BA, who had a short length of stay profile.

Figure 13 shows the mean number of laboratory reports per day at BAMC for the sample of DRG 122. Figures 12 and 13 indicate possible inconsistency in the use of laboratory services for DRG 122.

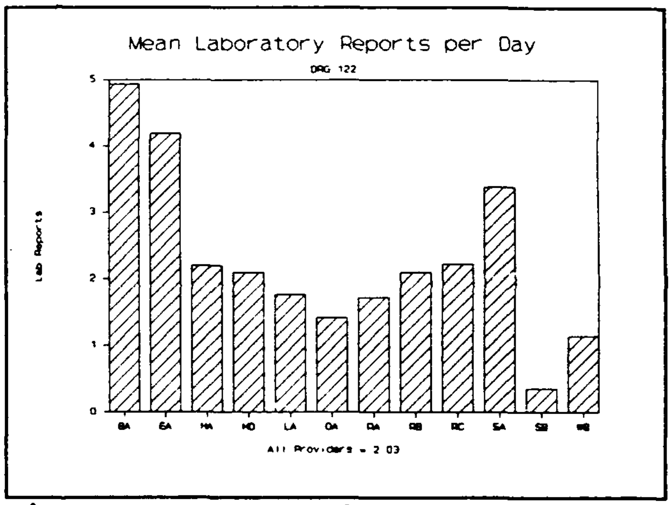

Figure 13 Mean Lab Reports per Day DRG 122

Stepwise regression analysis detected a significant correlation of LN-LOS with the variable DIAG. This finding could be due to the added complexity and acuity of patients with multiple health problems being more susceptible to severe illness.

Discharge planning by Social Work Service personnel was correlated with a longer length of stay. Patients with more complex social or home health care needs and those patients who were discharged to a nursing home tended to stay longer. When discharge planning is delayed arrangements for nursing home, or home health care may cause a deferral of the discharge until the plan is finalized. It is conceivable that a longer LOS allowed more time for Social Work Service personnel to document the health record.

The number of previous admissions to BAMC was negatively correlated with length of stay. If these patients had been admitted to BAMC for the same diagnosis, some information required to work up a new patient would be available in the health record. Some tests, procedures, and consultations with specialists would not be required since the required information was already available from previous admissions.

As in DRG 125 and DRG 143 the number of pre-operative days was positively correlated with length of stay for DRG 122. Pre-operative days in the case of DRG 122 are composed of days waiting for a major procedure. Diagnostic imaging or cardiac catheterization are the most frequent categories of procedures. Most patients requiring diagnostic imaging were admitted with an ambiguous diagnosis. Patients admitted for "Acute Myocardial Infarction, Unspecified Site" (ICDM-9-CM 4109) or "Chronic Ischemic Heart Disease, Unspecified Site" (ICDM-9-CM 4149) may have a diagnostic requirement which prolongs their LOS due to backlogged procedure schedules. Over 29 percent of all patients not having a cardiac catheterization, but having some other procedure, are discharged within 24 hours of the procedure. However, it is likely that the attending physician will decide to wait until the patient has nearly recovered before placing the patient under the stress of certain tests. It is also possible some patients remain in the hospital beyond the stage where they are well enough for discharge in order to complete tests. An alternative to a prolonged LOS could be an earlier discharge with appointments for tests as an an outpatient.

Stepwise regression analysis detected a significant correlation of LN-LOS with the independent variable DIAG. The number of diagnoses was significant for a positive correlation with LN-LOS. This finding could be due to the added complexity and acuity of patients with multiple health problems.

Admission on a Thursday was correlated with a longer length of stay for DRG 122. This finding could be due to the proximity of Thursday admissions with the weekend. Saturday and Sunday are days when the majority of BAMC staff do not report for work. The effect of weekend staffing is many services are curtailed or have limited availability. Without necessary consultative, diagnostic, and administrative services available to the attending physician at the right time, LOS is prolonged.

Short Stay Outlier Diagnosis Related Groups.

Analysis of DRG 014.

Circulatory disorders except acute myocardial infarction, without complex diagnosis, is the 51st most frequently occurring DRG at BAMC. PASBA counted 74 dispositions in FY 87, which amounted to 732 total bed days. DRG 014 is ranked 17th most frequently occurring diagnostic group within the Department of Medicine. When the ALOS for BAMC dispositions are compared to either CHAMPUS or the Peer Group, BAMC ALOS is significantly shorter.[2]

Stepwise regression analysis identified eight significant variables which explain approximately 74% of the total variation in the LOS for DRG 014. The variables selected by the Final Model were BA, SD, ZIP, ER, CON, LAB, SWDP, and PRE-OP. Table XX of Appendix C is a listing of these variables and their statistics. Appendix C is accompanied with a discussion of the significance of these statistics.

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The mean length of stay for the sample cases of DRG 014 was 5.11 days. However, mean LOS among providers varied considerably. Figure 14 shows LOS by physician. BC and HD LOSs are longer than the mean for all providers. AA, BA, and NA had LOSs shorter than the mean for all providers. BA's mean LOS is only 2.5 days. The number of cases was not distributed evenly among all providers and many providers had case numbers that were too small to allow conclusions.

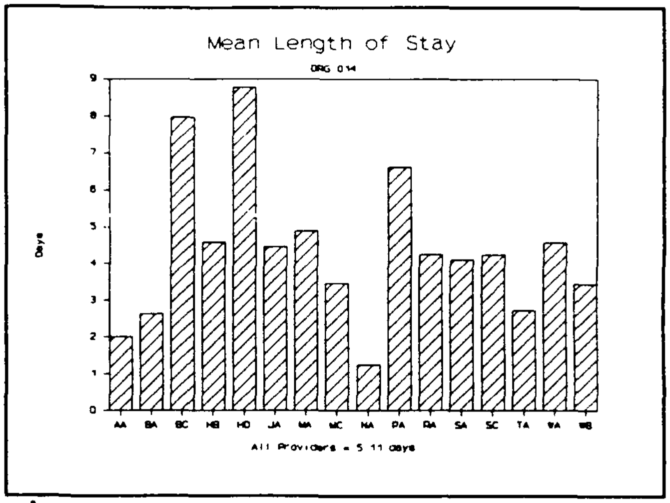

Figure 14 ALOS DRG 014

Figure 15 shows the number of cases per physician varies from two cases to six cases. Providers with less than two cases are not shown. Of the two provider variables selected by the final model, Only BA had more than one case. SD had only one case.

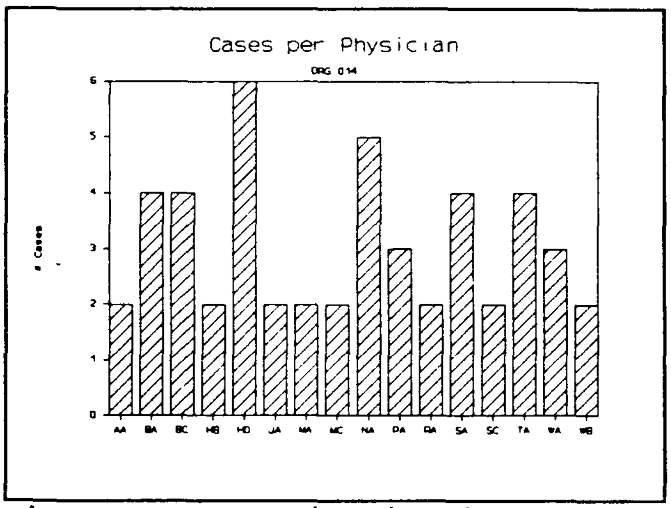

Figure 15 Case Distribution
DRG 014

The number of pre-operative days was positively correlated with length of stay for DRG 014. Pre-operative days for DRG 014 are composed of days waiting for a major procedure. Figure 16 depicts the mean number of Pre-operative days per stay by physician. Note the low of .25 days for BA and the high of 4.5 for BC. Diagnostic computerized axial tomography of the head and other type of imaging are the most frequent categories of procedures. A patient may have a diagnostic requirement which prolongs their LOS due to backlogged procedure schedules. It is also likely that the attending physician waits until the patient's condition has improved before placing the patient under the stress of certain tests. Access to diagnostic procedures is limited on an outpatient basis because of the demand for services and the current capabilities within the Department of Radiology. Since inpatient diagnostic procedures have a priority, it is not unusual to admit marginally ill patients for imaging or other diagnostic services.

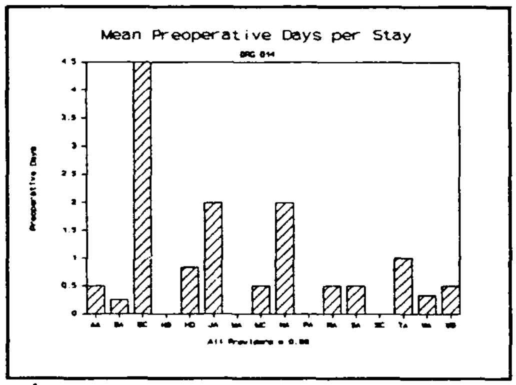

Figure 16 PREOP Days - DRG 014

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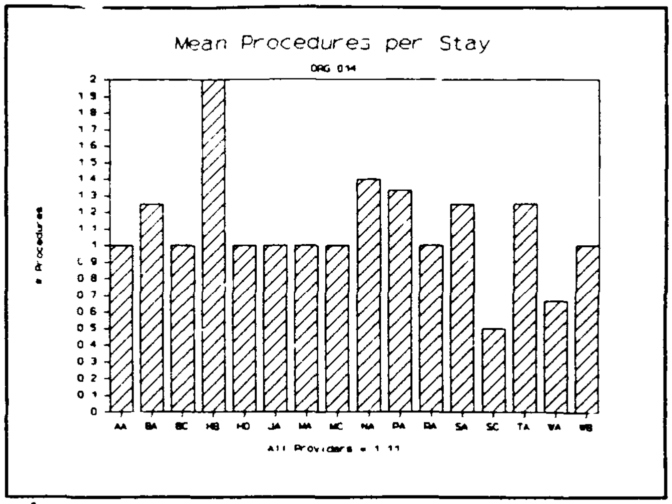

Figure 17 Procedures - DRG 014

Figure 17 represents the mean number of procedures per stay by physician. Note that the mean for all physicians, except SC and WA is one or greater. Note also, that the range for procedures is very narrow. If providers were admitting to gain access to diagnostic procedures, one would expect to see 1) short LOSs, 2) few pre-operative days, and 3) at least one procedure per stay. Provider BA meets these three criteria.

Patients having addresses outside the greater San Antonio area were correlated with longer LOS for this DRG. Patients who are referred from other facilities which do not have the physician specialists or the diagnostic equipment frequently require more medical attention than patients admitted from the local San Antonio area. Patients referred from other medical treatment facilities have had some degree of medical attention, and a medical work-up indicating a requirement for services beyond the scope of a MEDDAC.

Thorpe found that admission through the emergency room was a significant indicator for higher costs and hypothesized that patients admitted through the emergency room had a greater severity of illness.[3] The unexpected result of the regression analysis for DRG 014 assigned the variable ER a negative coefficient, implying admission through the emergency room has an inverse relationship with length of stay. This discrepancy could be explained if patients were being admitted for diagnostic imaging or other procedures.

The number of consultations is positively correlated with LOS and was identified as a significant variable by stepwise regression of the final Phase II Model. Figure 18 is a display of the mean number of consultation reports found in records, per stay, by provider. A higher number of consultation reports seem to have been requested by HD, MA, and NA. The mean number of consultations for all cases was 2.02. The importance of a consultation service may lie in the timeliness of the report. Consultation requests categorized as routine may not be completed within 24 hours. Consultations with specialists can drive determination of the final diagnosis, treatment plans, and the DRG assignment.

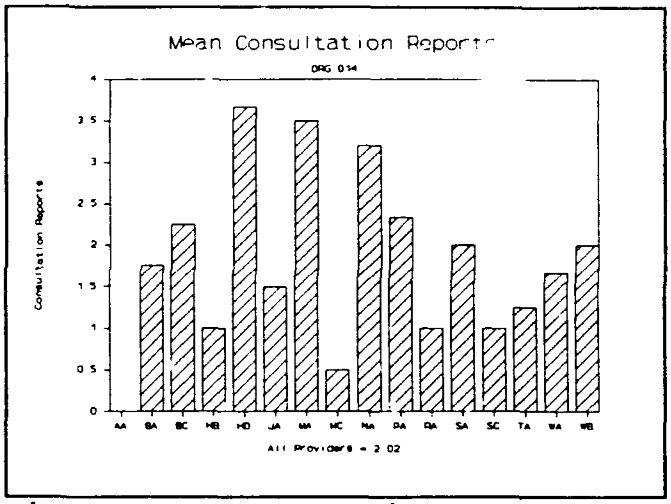

Figure 18 Consultations - DRG 014

Stepwise regression analysis detected LAB as a significant variable. Use of laboratory services varies among physicians in the Department of Medicine.

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Figure 19 depicts the mean number of laboratory reports found in each record of the sample for DRG 014. The mean number of laboratory reports for all providers was 9.54 reports. HD appears to have greater usage of laboratory services than his or her peers.

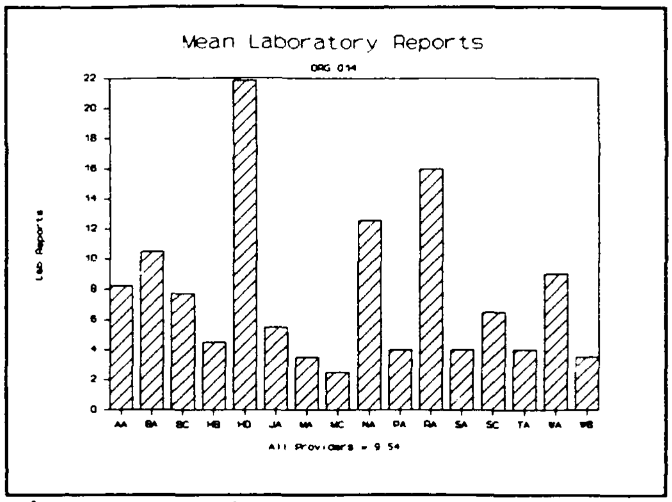

Figure 19 Lab Reports - DRG 014

Figure 20 shows the mean number of laboratory reports per day at BAMC for the sample of DRG 014. The mean number of laboratory reports per day brings HD's profile closer to his or her peers. Conversely, NA who had a short length of stay profile, stands out.

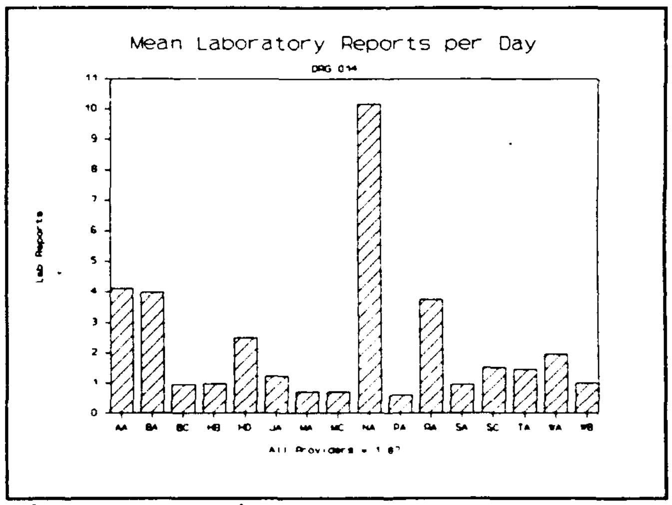

Figure 20 Daily Lab Reports DRG 014

Discharge planning by Social Work Service personnel was correlated with a longer length of stay. Patients with more complex social or home health care needs, and those patients who were discharged to a nursing home tended to stay longer. It is also conceivable that the extra time the

more debilitated patients stayed in the hospital allowed more time for Social Work Service personnel to document the health record.

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Analysis of DRG 097.

Bronchitis and asthma, age 18-69, without complications, is the 61st most frequently occurring DRG at BAMC. PASBA counted 65 dispositions in FY 87, which amounted to 165 total bed days. DRG 097 is ranked 20th most frequently occurring diagnostic group within the Department of Medicine. When the ALOS for all of BAMC dispositions for this group are compared to those of either CHAMPUS or the Peer Group, the BAMC ALOS is significantly shorter than both.[2]

Stepwise regression analysis identified ten significant variables which explain approximately 79% of the total variation in the LOS for DRG 097. The variables selected by the Final Model were AA, LA, MA. NA, SC, A-FRI, D-TUE, CON, LAB, and SWDP. Table XXIV of Appendix C is a listing of these variables and their statistics.

The mean length of stay for the sample cases of DRG 097 was 1.72 days. Figure 21 shows LOS by physician. Mean LOS among providers for DRG 097 appears to be moderately consistent. With one exception, all providers fall within a band extending + or - 0.4 day from

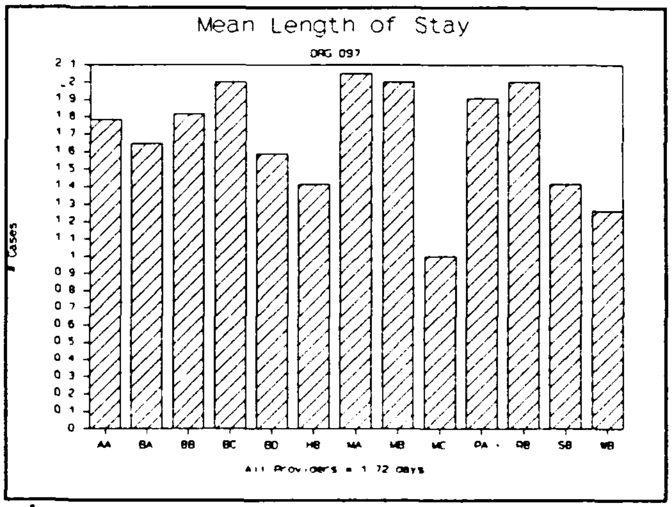

Figure 21 ALOS - DRG 097

the mean. Provider MC is the exception, with a mean LOS of 1.1 days.

The number of cases was not distributed evenly among all providers, and many providers had an insufficient number of cases to allow conclusions. Figure 22 graphically depicts case distribution by physician. Physicians with fewer than two cases are not shown. LA, NA, and SC had only one case grouped into DRG 097. Of the physician providers selected for the Final Model, only MA and AA had more than one case.

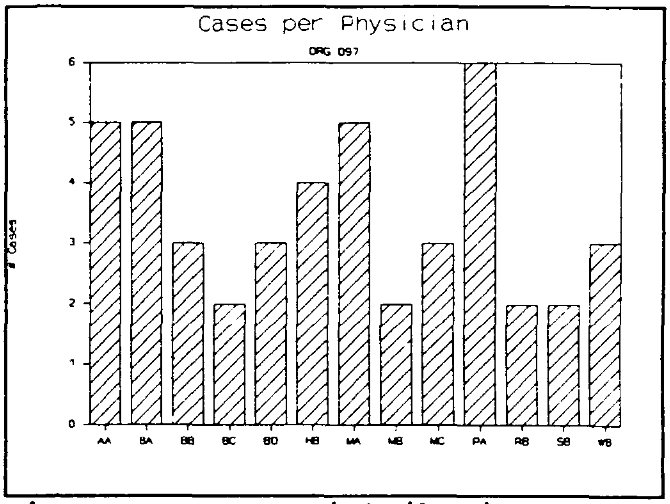

Figure 22 Case Distribution DRG 097

The number of consultations is negatively correlated with LOS and was identified as a significant variable by stepwise regression of the final Phase II set. Figure 23 is a display of the mean number of consultation reports found in records, per stay, by provider. It is

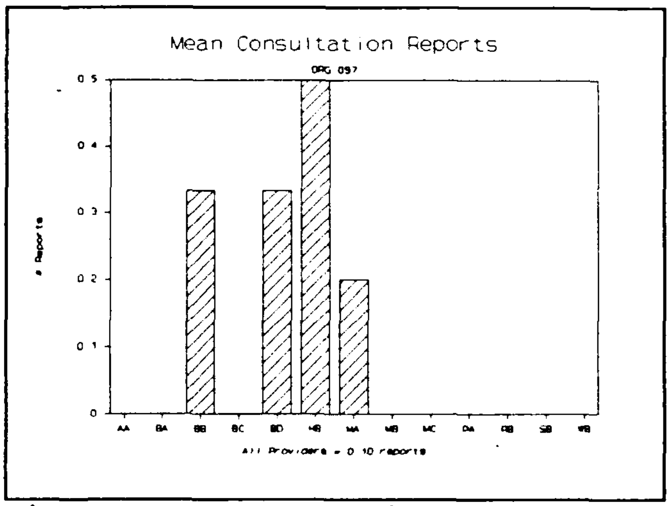

Figure 23 Consultations - DRG 097

conspicuous that only four providers requested consultation reports. The mean number of consultations for all cases was only 0.10 reports per provider. Consultation requests for pulmonary function tests are usually completed within hours. These consultations can drive determination of the final diagnosis, treatment plans, and the DRG assignment.

The date of admission and discharge was significant for LOS. Admission on a Friday and discharge on a Tuesday was correlated with a longer length of stay for DRG 097. This finding could be due to the proximity of Friday admissions and Tuesday discharges with the weekend. Saturday and Sunday are days when the majority of BAMC staff do not report for work. The effect of weekend staffing is many services are curtailed or have limited availability. Without necessary consultative, diagnostic, and administrative services available to the attending physician at the right time, LOS is prolonged.

Stepwise regression analysis detected LAB as a significant variable. Use of laboratory services varies among physicians in the Department of Medicine. Figure 24 depicts the mean number of laboratory reports found in each re-

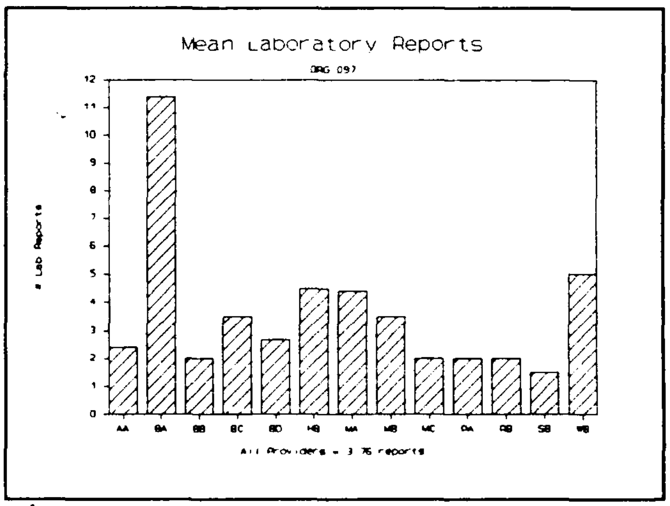

Figure 24 Lab Reports - DRG 097

cord of the sample for DRG 097.

The mean number of laboratory reports for all providers was 3.76 reports. BA appears to have greater usage of laboratory services than his or her peers.

Discharge planning by Social Work Service personnel was correlated with a longer length of stay. Patients with more complex social or home health care needs, and those patients who were discharged to a nursing home tended to stay longer. It is also conceivable that the extra time that the more debilitated patients stayed in the hospital allowed more time for Social Work Service personnel to document the health record.

Analysis of DRG 172.

Digestive malignancy age >69 is the 85th most frequently occurring DRG at BAMC. PASBA counted 48 dispositions in FY 87, which amounted to 344 total bed days. DRG 172 is ranked 32nd most frequently occurring diagnostic group within the Department of Medicine. When the ALOS for BAMC dispositions are compared with CHAMPUS or the Peer Group, BAMC ALOS is significantly shorter.[2]

Stepwise regression analysis identified five significant variables which explain approximately 79.7% of the total variation in the LOS for DRG 172. The variables selected by the Final Model were SA, A-THR, LAB, PROC and DIAG. Table XXIII of Appendix C is a listing of these variables and their statistics.

The mean length of stay for the sample cases of DRG 172 was 3.75 days. Figure 25 shows LOS by provider. Note that the Department of Surgery accounted for six cases that are shown as one group,"SURG." Mean LOS among providers for DRG 172 appears to be extremely variable. Provider OA and RB stand out with mean LOS longer than their peers. Three other providers have LOSs twice the mean

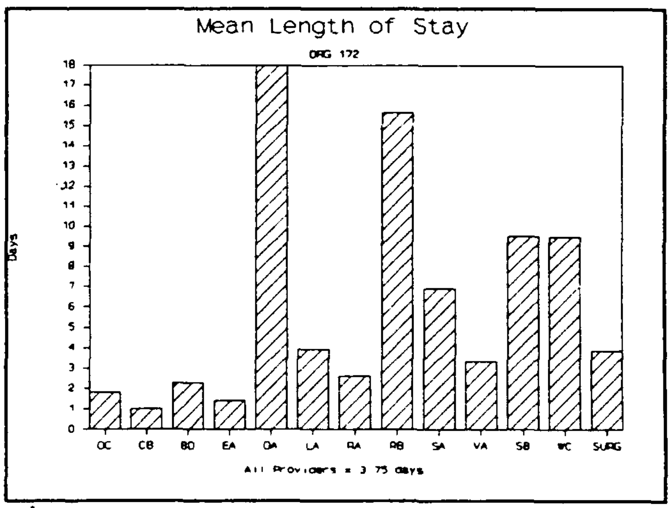

Figure 25 ALOS DRG 172

for all providers.

The number of cases was not distributed evenly among all providers and many providers had too few case numbers to allow conclusions. The small number of cases grouped into DRG 172 make this category very difficult to analyze. Figure 26 graphically depicts the cases distribution by physician. Physicians with fewer than two cases are not shown.

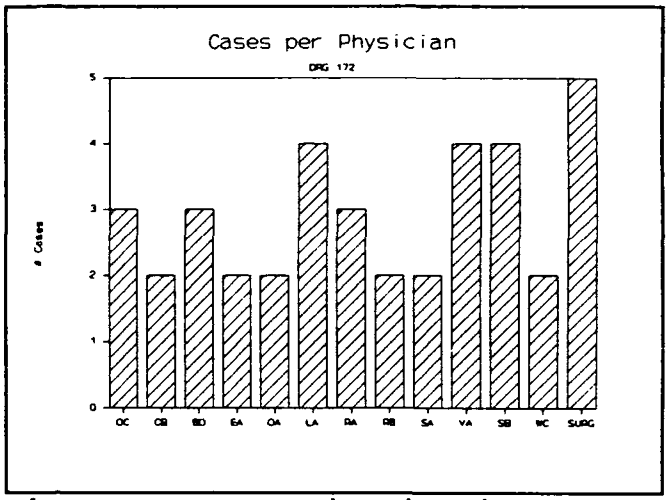

Figure 26 Case Distribution DRG 172

PROVIDER variable SA had only two cases grouped in DRG 172, an insufficient number to formulate a conclusion.

The date of admission was significant for LOS. Admission on a Thursday was correlated with a longer length of stay for DRG 172. This finding could be due to the proximity of Thursday admissions with the weekend. Saturday and Sunday are days when the majority of BAMC staff do not report for work. The effect of weekend staffing is many services are curtailed or have limited availability. Without necessary consultative, diagnostic, and administrative services available to the attending physician at the right time, LOS is prolonged.

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Discharge planning by Social Work Service personnel was correlated with a longer length of stay. Patients with more complex social or home health care needs, and those patients who were discharged to a nursing home tended to stay longer. It is also conceivable that the extra time that the more debilitated patients stayed in the hospital allowed more time for Social Work Service personnel to document the health record.

Stepwise regression analysis detected LAB as a significant variable. Use of laboratory services varies among physicians in the Department of Medicine. Figure 27 depicts the mean number of laboratory reports found in each record of the sample for DRG 172. The mean number of laboratory reports for all providers was 9.17 reports, with most physicians using between 5 and 20 laboratory procedures per case. WC appears to have greater usage of laboratory services than his or her peers.

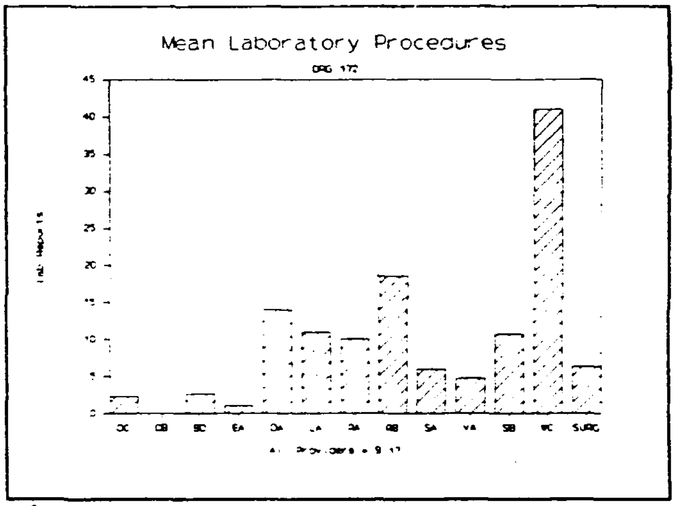

Figure 27 Lab Reports - DRG 172

The number of diagnoses was significant for a positive correlation with LOS. This finding could be due to the added complexity and acuity of patients with multiple health problems.

Endnotes

1. Payne, Susan M.C. "Pew Memorial Trust Policy Synthesis: Identifying and Managing Inappropriate Hospital Utilization." Health Services Research. 22.5 (1987a): 709-69.

2. United States Army Health Services Command. "Length of Stay Study: Diagnosis Related Groups - BAMC VS Peer Groups." U.S.A. Patient Administration Systems and Biostatistics Activity, Fort Sam Houston, Texas. 1988.

3. Thorpe, Kenneth E. "Why Are Urban Hospital Costs So High." Health Services Research. 22.6 (1988): 821-36.

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CHAPTER III

VARIABLE ANALYSIS AND RECOMMENDATIONS

General.

Hospital administrators have frequently focused on long LOS outlier cases as an indicator for concurrent retrospective review. Medical Record Audit Committees, Utilization Review Committees, and Quality Assurance Committees often use a LOS trim point to trigger retrospective review. However, audits of records by Peer Review Organizations and other external review organizations show alarming numbers of inappropriate days from cases that are within generally accepted LOS standards.[1] Thus, the first question of utilization review is: "Where to begin?"

Effective utilization management must have a substantial scope. A focus limited to length of stay will only manage the last and least valuable days of care. The product of utilization review should be the management of input resources for the production of healthier patients.

Efficient utilization management must focus on those variables which have the greatest influence on resource use. While civilian institutions can manage UR for 100% of all inpatient cases, government institutions have limited administrative overhead available to indirect patient care endeavors. Government institutions are particularly constrained by the number of administrative personnel allocated to UR activities.

Since UR is expensive, selection criteria for case review is crucial. Using a set of criteria to narrow the focus is one approach to glean the most from available assets. Payne recommended targeting UR to diagnostic categories in which there are deviations in LOS.

Comparative analysis of DRGs among peer group medical treatment facilities is a method for identifying the target diagnostic related groups. Targeting DRGs alone will not concentrate the number of individual cases a UR committee can manage. Additional criteria should be set to trigger or screen for the review process. Preferably, a set of prearranged UR criteria will permit concurrent review to prevent unnecessary use of resources.

Variables which explain the variance in BAMC ALOS will not explain what contributes or causes BAMC's ALOS to differ from the CHAMPUS ALOS or the Peer Group ALOS. However, identifying, then monitoring and evaluating the variables which are related to LOS could be part of the UR process for better management.

Control and Demographic Variables.

Four variables were used to control for race and sex. The control variables were SEX, BLACK, WHITE, and OTHER. The Final Phase I regression Models dropped SEX, BLACK, and WHITE from all models. OTHER remained in the PHASE II data set as a control for DRGs 132, 122, and 097. However, OTHER was dropped from the

Final Phase II Models of DRGs 132, 122, and 097 and no control variable was judged to be significant in any final regression model.

Six variables were coded to account for beneficiary status or category. These variables were named MIL, RET, ADP, RDP, SCV, and NCV. The Final Phase I regression Models dropped SCV, ADP, and NCV from all models. MIL was significant to the PASBA data set regression equation and remained in the Phase II data set for DRG 122. MIL was then later removed from the Final Phase II equation during stepwise regression analysis of DRG 122. RDP was significant to the PASBA data set regression equation and remained in the Phase II data set for DRG 172, but was removed from the Final Phase II model by stepwise regression analysis. RET was significant to the PASBA data set regression equation and remained in the Phase II data set for DRG 014. RET was then later removed from the Final Phase II equation during stepwise regression analysis of DRG 014.

AGE was significant to the PASBA data set for DRG 125, however this variable was also eliminated from all final equations by stepwise regression. It is important to recall that age is a grouping consideration for DRG 132, DRG 097, and DRG 172 as well as other DRGs considered for analysis.

ZIP was coded to differentiate patients having local addresses from those patients who live outside the San Antonio metropolitan area. ZIP remained in the Final Model for DRG 014. Since BAMC is a tertiary care and referral center, patients who are referred from other facilities could be expected to be sicker and have a longer length of stay. This finding is supported by Thorpe's previous work.[2]

Except for ZIP, demographic and control variables did not significantly explain variance in LOS for any of the final equations. This finding is consistent with the research conducted to develop Diagnostic Related Groups, and further demonstrates the validity and the reliability of the DRG. Conventional wisdom at BAMC holds that non-sponsored (indigent) civilian emergencies are sicker and stay longer than sponsored patients. These findings do not support such beliefs.

Day of Admission and Day of Discharge.

The day of the week a patient is admitted to BAMC or discharged home was associated with longer LOS for four DRGs. *Admission on a Thursday was significant* for DRGs 122 and 172. Admission on a Friday was significant for DRG 097. Discharges on Tuesday were also associated with longer LOS for DRG 097. The significance of these days probably lies in their immediacy with the weekend when services are curtailed. While hospitals are noted for their 24-hour-per-day, seven-day-per-week enterprise, activity after normal duty hours (1700) and on weekends and holidays subsides.

These results parallel those of Lave and Leinhardt who reported admissions on Mondays and Tuesdays had LOSs 10 per cent less than admissions later in the week.[3] A marginal decrease in LOS could be achieved if elective admissions were scheduled earlier in the week. Given that hospital services are reduced after duty hours, providers could add to the managerial efficiency of BAMC by giving some thought to admission planning.

Use of Ancillary and Consultative Services.

Some of the strongest, and most frequent LOS associations cluster around the variables related to the use of ancillary and consultative services. Table VIII illustrates one or more of these variables was significantly associated with every DRG studied. Kelly, Weng, and Watson found similar results using Blue Cross and Blue Shield of Michigan data.[4]

Table VIII Significant Ancillary & Consultative Service Variables

Variable	DRG 125	DRG 143	DRG 132	DRG 122	DRG 014	DRG 097	DRG 172	Total
CON	NO	YES	YES	YES	YES	YES	NO	5
LAB	YES	NO	NO	YES	YES	YES	YES	5
PRE-OP	YES	YES	NO	YES	YES	NO	NO	4
PROC	YES	YES	YES	NO	NO	NO	NO	3

Except for the number of procedures (PROC), ancillary service variables were significant to both long and short stay outlier DRGs. PROC was significant to long stay outlier DRGs, exclusively. Length of stay associated with these services is composed of two factors: the time that the patient waits for the service and the time the provider waits for the results. Preadmission consultation, imaging, and laboratory work-up could be one LOS conserving approach if the services were available and responsive to timely admission planning. Frequently, patients are admitted strictly for timely access to these services since outpatient appointments have long waiting periods.

Laboratory processing time can be significantly decreased with automated laboratory systems that interface on-line laboratory instruments to terminals in clinics and wards. The recently installed Regenstrief system has the capability to improve the timeliness of repoɿting and decrease the manual labor involved in laboratory paper transactions. "Lost" laboratory reports are instantly available to on-line queries. While timeliness of reporting is improved, the volume of requests for "lost" reports decreases.[5]

The capability to manage the use of ancillary resource inputs is tied to the capability to acquire and process data from ancillary services. High volume inputs such as laboratory services can be monitored retrospectively using information gathered on the Regenstrief system. Only the most expensive services can be reviewed concurrently on a case by case basis. Standards of care for use of ancillary services should developed by the most respected staff members, using up-to-date literature and presented in forums of education.[6]

Two variables related to the use of ancillary resources which were not studied but require notice are pharmacy and radiographic inputs. The absence of these variables restrains the econometric applicability of this study and limits the degree of variance explanation in the regression models. Further research incorporating these variables is crucial.

PROVIDER

At least one physician provider was found to be significantly associated with length of stay in each DRG studied. PROVIDER was related to a negative coefficient of correlation about 30% of the time. The findings of this research show strong association between length of stay and the physician responsible for the care. Numerous researchers report that a significant amount of the variability in the use of resources is due to individual physician practice patterns, including: Borchardt[7]; McClure;[8] McMahon and Newbold;[9] and Restuccia and Kreger.[10]

It is obvious that the physician is the central and most critical element in the management of the patient's course in the hospital. Any changes in productivity, services, technology, or management strategies will rely on collaboration with the practicing physician, the providers of health services. Change is necessary and continuous in health care delivery. Use of invasive procedures is declining and the practice for many disciplines such as gastroenterology and cardiology is moving to the outpatient setting. The growth of ambulatory care services in the civilian sector has expanded with the shift to a prospective payment system and accelerated improvements in technology.[11]

To effect a change in productivity, quality, or utilization of resources, individual physician behavior requires an information system that provides meaningful data on a regular basis. Physicians are uninformed about aggregate data on their performance profiles. "Most physicians will want to perform well, but they can only do so when they can judge their own performance against that of their peers or against plan norms."[12] Extending feedback on the status of resource consumption to providers is a starting point for self-directed change. To preserve clinical autonomy, the primary interpretation of the data is left to the individual provider.

Accountability for resource use in health care institution is lacking due to the lack of standards for comparison of the value of services.[13] However, accurate measurement of resource consumption is critical to sustained performance of a health service institution and accountability for the use of resource inputs must be placed on those who are also responsible for producing quality outputs.

Both quality and economy can be achieved if a consensus is reached on the norms of aggregate expectations. Griffith defines clinical expectations as "...the consensuses reached on the correct professional response to specific, recurring situations in patient care."[14] Data collected from a set of variables associated with LOS can be used to develop a historical and comparative data base. The data base can be a source for reaching a more formal consensus on clinical expectations.[15]

The finding of this report cannot attribute causality of LOS with the provider. There was no method to differentiate severity of illness between cases. Further, the power of association between LOS and PROVIDER is weakened by the small number of observations for each PROVIDER. For this variable to be effective in an operational setting, virtually all cases within targeted DRGs would be needed to make a meaningful comparison. Methods of analysis to compare providers might include

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Number of Admissions and Source of Admission.

Admission through the emergency room was significantly associated with length of stay for two DRGs. Admissions through the ER for DRG 143, a long stay outlier, were associated with a longer LOS. Admissions through the ER for DRG 014, a short stay outlier, were associated with a short LOS. Unplanned admissions reflect significance for several possible reasons.

Unlike clinics within the department of medicine, the decision to use emergency room facilities is at the discretion of the patient. The patient's decision to seek care in the ER usually rests on the availability of after hours services and a perceived medical crisis.

Patients who seek care in the emergency room may have waited until the illness has reached some level of crisis or they do not have convenient access to other care. Patients in a medical crisis are sicker and often require greater resources and need longer recovery periods.

Admissions through the emergency room are unplanned admissions. Treatment plans for unplanned admissions are started by physicians in the ER who have little or no knowledge of the patients medical history. Planned admissions have the advantage of cutting length of stay. Laboratory work, imaging studies, and other pre-admission work is done before the patient occupies a bed.

The thrust of the initial stages of treatment in an emergency room are to stabilize the patient and manage the crisis. Once the patient is transferred to a ward or intensive care unit a new physician is assigned to his or her case. Thorpe found that emergency room admissions were associated with greater costs as well as a longer length of stay.[17] Many patients who are admitted for observation, or to rule out a more serious diagnosis, may have a very short stay; they literally get well over night.

After hours clinics can be an alternative to the ER. Such clinics can serve as a triage and referral control point. Extension of office hours will also allow the staff to be scheduled such that the cramped office and clinic space can be used with greater efficiency and productivity. Extension of clinic working hours would be necessarily linked to the extension of ancillary and administrative support. To improve productivity and be effective, the range of services available during the extended period should be comparable to normal hour clinics.

The number of admissions was found to be associated with the length of stay for DRG 122, circulatory disorders except acute myocardial infarction, without cardiovascular complication. Conceptually, the number of past admissions is related to the complexity of the patient. Patients with many past admissions for the same illness may tend to get sicker. Patients with several illnesses often receive treatments for more than the single discharge diagnosis and thus stay longer.

Discharge Planning.

Discharge planning variables were significantly associated with length of stay in four out of the seven DRGs studied. The social workers' discharge plans were significantly associated with one long stay outlier, DRG 122 and two short stay outliers DRGs 014 and 097. The nurses' discharge plans were significantly associated with DRG 143 a long stay outlier. All associations with discharge planning were for longer lengths of stay.

The findings for the social workers' discharge planning are comparable to those of Marchette and Holloman.[18] They made the reasonable conclusion that social workers planned discharges for patients with long hospital stays needing more postdischarge home assistance or nursing home placements. A similar case can be made for the results found in this study.

Marchette and Holloman's results are partially incompatible with the results found for Nurses' discharge plan. They found that discharge planning directed by nursing was associated with a decrease in the LOS. However, they also found that the timing of the discharge plan was critical to its effectiveness. For every day that a nurse's discharge plan was postponed, there was a 0.8 day increase in LOS. The relationship found between longer length of stay at BAMC and the nurse's discharge planning may be related to the timing of the discharge plan.

Good discharge planning is really admission planning. A decision to admit must be weighed against an outpatient strategy. An overall plan for inpatient visit should include an estimate of LOS, scheduled procedures, expected outcomes, rehabilitation requirements, and social service needs. Equipment needed for home health care and family training must be ordered early to avoid extra days in the hospital due to delays.[19]

To organize these activities, many hospitals employ a UR coordinator (URC) or discharge planning coordinator. The great utility of the URC lies in the real time, concurrent review process. Both quality and resources are monitored and evaluated for optimal use. Management is facilitated by case information gathering, hospital rounding, and team coordination. Kongstvedt believes that the UR nurse "... is critical to the success of a managed care program..."[20] Establishment of a department level discharge planning coordinator will be critical to successful management in the Department of Medicine.

Predictor Variables.

A reasonable conjecture is that a prediction of a patient's stay could be made if the components of LOS were known upon admission. Of the fourteen variables found to be significantly associated with LOS, eight could be applied at admission to predict LOS.

Unfortunately, all eight are not significant to any one DRG. Table IX shows that from one to four variables could possibly be used to approximate a patient's LOS upon admission. These variables, coupled with an accurate admitting DRG, could be a powerful tool for concurrent utilization management and early discharge planning. Further analysis is necessary to refine and validate this finding. It is recommended that some measure of severity or patient classification be included in any future endeavor. Kay, Rieder, and Hall concluded that some measurement of disease severity could explain 25 to 30 percent of the variance in the LOS of certain DRGs.[21]

Table IX Predictor Variables

Variable	DRG 125	DRG 143	DRG 132	DRG 122	DRG 014	DRG 097	DRG 172
A-THR	NO	NO	NO	YES	NO	NO	YES
A-FRI	NO	NO	NO	NO	NO	YES	NO
D-TUE	NO	NO	NO	NO	NO	YES	NO
DIAG	NO	YES	NO	YES	NO	NO	YES
PROVIDER	YES	YES	YES	YES	YES	YES	YES
ZIP	NO	NO	NO	NO	YES	NO	NO
ER	NO	YES	NO	NO	YES	NO	NO
ADM	NO	NO	NO	YES	NO	NO	NO
Total	1	3	1	4	3	3	3

Utilization Management Decision Support.

Ideally, a managerial control system would include a cost accounting system to measure the dollar value of all inputs into the production of DRGs. Unfortunately, BAMC, like many other institutions does not have a cost accounting system capable of providing DRG level information. However, BAMC does have various other management information systems (MIS) that collect or produce input variable data. It is possible to build a utilization management decision support system (UM-DSS) by linking these data elements with the proper software and hardware.

BAMC could be in a good position to use available data sources to initiate an effective and efficient utilization management (UM) system. Manpower dedicated to UR can be minimized by the use of automated data processing (ADP) equipment to develop a decision support system (DSS). A DSS could be developed from existing or proposed ADP systems and mini or microcomputer based hardware, such as that used for this research project. The UM-DSS architecture would consist of three major components, the software system, the data base, and the model base.[22]

Data bases already incorporated into existing MISs such as *AQCESS, TRIRAD,* the *Composite Health Care System,* and the *Regenstrief* laboratory system would constitute the data base portion of the architecture. The obvious advantage of using existing data bases is reduced implementation cost. Much of the data is already captured during normal transactions using existing labor. Data from existing MIS data bases can be extracted using existing ad hoc report generators and down loaded into the decision support data base. Data elements used in the UM-DSS have already been standardized within the other systems, thus the information produced by the system is comparable with other MIS reports.

The model base would consist of standard off the shelf software packages including spreadsheet, statistical software packages, graphics packages, and operations research packages. Software packages such as *Microstat* or *SPSS PC* would function adequately in this environment. The batch mode capabilities of *Microstat* will allow the model base management system to bypass and overcome the limitations of its menu driven man-machine interface (Microstat, 1986). The model base would be resident on the system micro or minicomputer.

The software system is also resident on the DSS computer and consists of custom made and off the shelf software packages. The software system components function to link the user with the data base and the model base. The three components the software system are: 1) The data base management software (DMBS); 2) The model base management software (MBMS); and 3) A dialogue system for managing the interface between the user and the system.

Custom software would be developed to communicate with existing MIS data bases for inquiry and retrieval of data elements. An off the shelf DMBS such as *DBASE IV* would integrate data elements into a decision support data base. The MBMS is a set extracted using existing ad hoc report generators and down loaded into the decision support data base. Data elements used in the UM-DSS have already been standardized within the other systems, thus the information produced by the system is comparable with other MIS reports.

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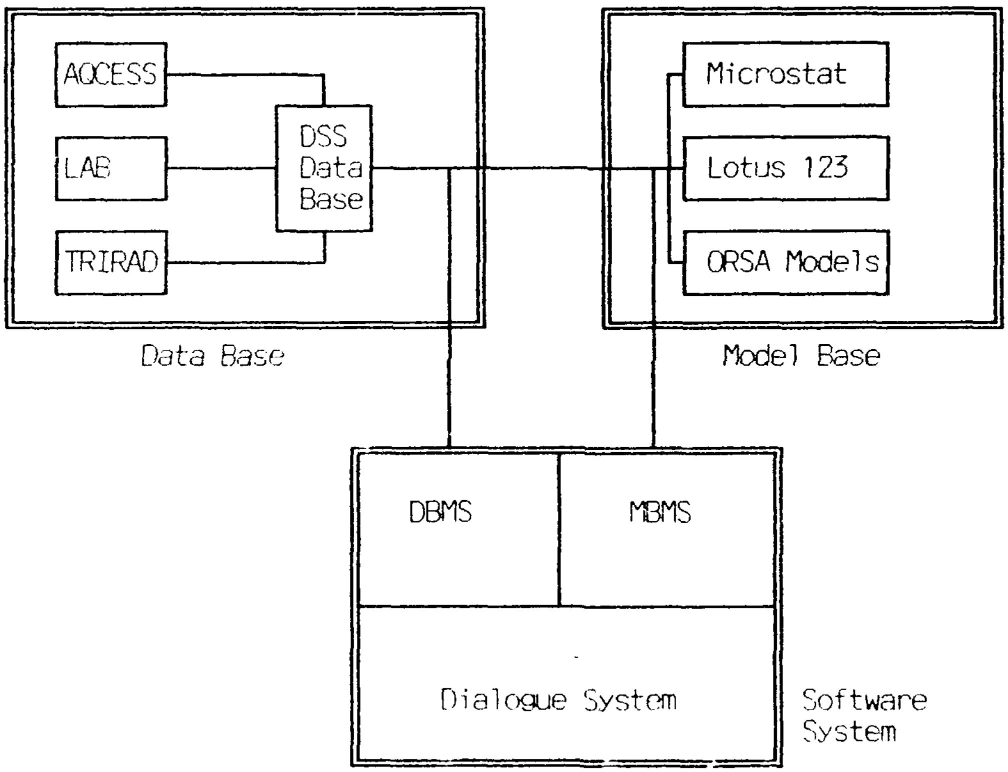
Custom software would be developed to communicate with existing MIS data bases for inquiry and retrieval of data elements. An off the shelf DMBS such as *DBASE IV* would integrate data elements into a decision support data base. The MBMS is a set of routines to manipulate the DSS data base and integrate the data into models to develop information for decision support. The dialogue system is software for managing the overall capabilities of the system. The dialogue system is the means for man-machine interface and is the software for stimulating the DSS input and output. Keyboard input may be enabled by simple menu driven batch files for running standard routines as or a rich command language. Outputs would be menus for dialogue, graphs, statistics, standard reports, or ad hoc reports.

Figure 29 A Builder's View of UM-DSS



From Sprague and Carlson *Building Effective Decision Support Systems* p. 29

Summary

The absence of financial data that can be directly linked to case data restricts analysis for UR and UM. Substituting inputs other than financial data may be necessary until better information is available. The variables selected by the final models have emerged from this research as acceptable substitutes.

The DRG was developed to be used as a tool for management of hospitals.[23] The DRG is a measure of output. Since the DRG is measurable it is therefore comparable. The DRG offers management the ability to identify the unusual elements in the patient care process, investigate their cause, and take action if necessary. However, past experience in the civilian sector indicates that health care leaders were frustrated to manage with the DRG because of a deficiency in useful management information.

Understanding the elements that contribute to the production of DRGs is critical to their management. Establishing a means to capture this data and convert it into usable information must be a priority if progress is going to be made after DRG implementation. By measurement and evaluation of these elements, the manager can effect positive changes to increase productivity and improve quality.

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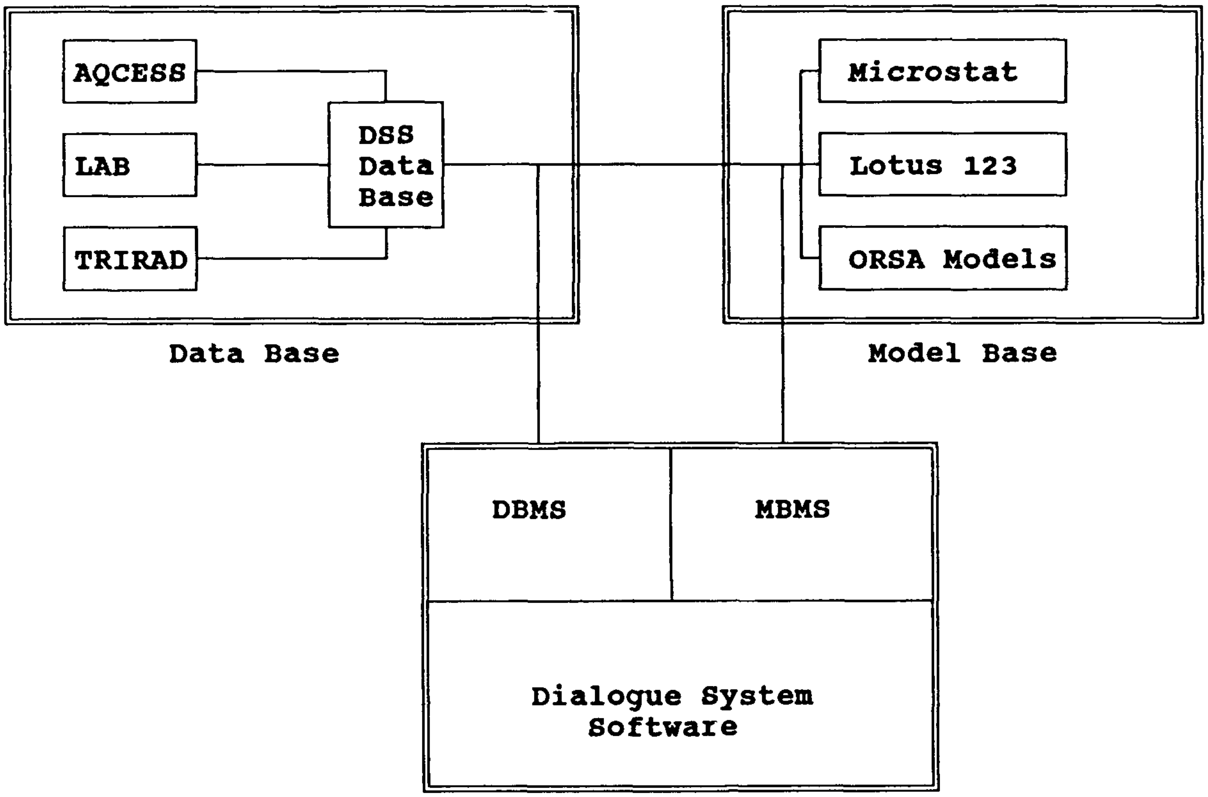
Figure 29 A Builder's View of UM-DSS



From Sprague and Carlson Building Effective Decision Support Systems p. 29

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Appendix A
Abbreviations

ADP	Automated Data Processing
ALOS	Average Length Of Stay
ASCII	American Standard Code for Information Interchange
BAMC	Brooke Army Medical Center, Fort Sam Houston, Texas
DRGs	Diagnostic Related Groups
DSS	Decision Support System
ICD-9-CM	International Classification of Diseases, 9th Revision with Clinical Modifications
IPDS	Inpatient Data System
LOS	Length Of Stay
MEDCEN	Medical Center
MEDDAC	Medical Department Activity
MIS	Management Information System
PASBA	Patient Administration Systems and Biostatistics Activity, US Army Health Services Command, Fort Sam Houston, Texas
QA	Quality Assurance
UM	Utilzation Management
UR	Utilization Review
USA	United States Army
USAF	United States Air Force
WMSN	Workload Management System for Nursing

APPENDIX B

Conversion Code

```
'
'
================================================================
===============
'
' DATA CONVERSION UTILITY for CPT SANFORD
'
' Dave St. Martin    10/29/88    GFA-BASIC Ver. 3.0
'
'
================================================================
===============
'
' Set Up Constants
'
CLEAR
x=0
drg$=" 0000 0 0000 0 0000 0 0000 "
proc$=" 000000 000000 000000 000000"
'
' ------------ Files Set-up ------------------------------------
'
CLOSE #1
CLOSE #2
CLOSE #3
'
OPEN "I",#1,"\TXT1"
OPEN "I",#2,"\TXT2"
OPEN "O",#3,"\FINAL"
'
'
' =========== Main Loop
==================================================
'
@g_string(a$,b$)                ! Sets first string in event of second
'
temp$=a$+b$
a$=""
b$=""
temp$=LEFT$(temp$,141)+drg$+MID$(temp$,141)+proc$
'
DO
  '
  @g_string(a$,b$)
  '
  IF MID$(a$,4,1)<>CHR$(32)      ! First Data Line
    @first_line(a$,b$,temp$)
  ELSE
    @second_line(a$,b$,temp$)    ! Second Data Line
  ENDIF
  '
LOOP WHILE NOT EOF(#1)           ! Files exhausted
```

```
'
@convert(temp$)
PRINT #3,temp$                  ! Output the last line
PRINT "WRITING LINE #:  ";x
'
CLOSE
END
'
' ==========  PROCEDURES  ==========================
'
PROCEDURE g_string(VAR a$,b$)
  '
  INPUT #1,a$
  INPUT #2,b$
  b$=MID$(b$,5)       ! Strip the line # from second half
  '
  @pad_fields(a$,b$)
  '
RETURN
PROCEDURE pad_fields(VAR a$,b$)
  '
  ' --------------------------------------------------
  ' Pad Line #1 w/ correct # Blank DRG Fields
  ' --------------------------------------------------
  '
  IF LEN(a$)=105
    a$=a$+" 0000  0  0000  0  0000  0"
  ELSE IF LEN(a$)=114
    a$=a$+" 0000  0  0000  0"
  ELSE IF LEN(a$)=123
    a$=a$+" 0000  0"
  ENDIF
  IF MID$(b$,3,1)=CHR$(32) OR LEN(b$)=0
    b$=" 0000  0"+MID$(b$,10)
  ENDIF
  '
  ' ------------------------------------------------
  ' Pad Line #1 B$ w/ correct # of Blank Procedure Fields
  ' ------------------------------------------------
  '
  IF LEN(b$)=9
    b$=b$+" 000000  000000  000000  000000"
  ELSE IF LEN(b$)=17
    b$=b$+" 000000  000000  000000"
  ELSE IF LEN(b$)=25
    b$=b$+" 000000  000000"
  ELSE IF LEN(b$)=33
    b$=b$+" 000000"
  ENDIF
  '
RETURN
PROCEDURE first_line(VAR a$,b$,temp$)
```

```
  '
  PRINT "WRITING LINE #:  ";x
  INC x
  @convert(temp$)
  PRINT #3,temp$    !Any time the NEW line is a First Line send old line to disk
  temp$=a$+b$
  a$=""
  b$=""
  temp$=LEFT$(temp$,141)+drg$+MID$(temp$,141)+proc$
  '
RETURN
PROCEDURE second_line(VAR a$,b$,temp$)
  '
  a$=a$+b$
  MID$(temp$,141,38)=MID$(a$,105,38)
  MID$(temp$,141,1)="0"
  MID$(temp$,209,30)=MID$(a$,141)
  '
RETURN
PROCEDURE convert(VAR temp$)
  '
  ' -------  Switch Gender ----------------
  '
  IF MID$(temp$,20,1)="M"
    gender$="1"    ! Gender = Male
  ELSE
    gender$="0"    ! Gender = Female
  ENDIF
  '
  ' -----  Switch Race Code  -------------
  '
  SELECT VAL(MID$(temp$,27,1))
    '
  CASE 1
    race$=" 1 0 0 0 0 0 0 "
  CASE 2
    race$=" 0 1 0 0 0 0 0 "
  CASE 3
    race$=" 0 0 1 0 0 0 0 "
  CASE 4
    race$=" 0 0 0 1 0 0 0 "
  CASE 5
    race$=" 0 0 0 0 1 0 0 "
  CASE 6
    race$=" 0 0 0 0 0 1 0 "
  CASE 7
    race$=" 0 0 0 0 0 0 1 "
  DEFAULT
    race$=" 0 0 0 0 0 0 0 "
  ENDSELECT
  '
  ' -----  Switch Patient Category  ------
```

```
'
SELECT MID$(temp$,45,3)
 '
CASE "A10","N10","M10","F10","C10","A70","N70","F70","C70","A80","N80","F80"
 pnt_cat$=" 1 0 0 0 0 0 "
CASE "P20","O20","A20","N20","M10","F10","C20"
 pnt_cat$=" 1 0 0 0 0 0 "
CASE "A30","N30","M30","F30","C30","P30","O30","A40","N40","M40","F40"
 pnt_cat$=" 0 1 0 0 0 0 "
CASE "C40","P40","O40"
 pnt_cat$=" 0 1 0 0 0 0 "
CASE "A50","N50","M50","F50","C50","P50","O50"
 pnt_cat$=" 0 0 1 0 0 0 "
CASE "A60","N60","M60","F60","C60","P60","O60"
 pnt_cat$=" 0 0 0 1 0 0 "
CASE "O10","O20","P10","P20","A90","N90","M90","F90","C90","P90","O90"
 pnt_cat$=" 0 0 0 0 1 0 "
CASE "H10","H20","H30","H40","H50","J10","J20","J30","K10","K20","K30"
 pnt_cat$=" 0 0 0 0 1 0 "
CASE "K40","K50","K60","K70","S10","S20","S30","S40","S50","S60","Q10"
 pnt_cat$=" 0 0 0 0 1 0 "
CASE "R10","X10","X20","X30","X40","X50","X52","X60"
 pnt_cat$=" 0 0 0 0 1 0 "
DEFAULT
 pnt_cat$=" 0 0 0 0 0 1 "
ENDSELECT
'
' ------ Convert Date of Disposition --------------
'
comp_date_dispos%=@comp_date(MID$(temp$,67,5))
dow_dispos|=@day_of_wk(comp_date_dispos%)
'
SELECT dow_dispos|
 '
CASE 1
 dow_dispos$=" 1 0 0 0 0 0 0"
CASE 2
 dow_dispos$=" 0 1 0 0 0 0 0"
CASE 3
 dow_dispos$=" 0 0 1 0 0 0 0"
CASE 4
 dow_dispos$=" 0 0 0 1 0 0 0"
CASE 5
 dow_dispos$=" 0 0 0 0 1 0 0"
CASE 6
 dow_dispos$=" 0 0 0 0 0 1 0"
CASE 7
 dow_dispos$=" 0 0 0 0 0 0 1"
DEFAULT
 dow_dispos$=" 0 0 0 0 0 0 0"
 '
ENDSELECT
```

```
'
' ------ Calculate Date of Admission --------------
'
bed_days%=VAL(MID$(temp$,74,3))
comp_date_admis%=SUB(comp_date_dispos%,bed_days%)
dow_admis|=@day_of_wk(comp_date_admis%)
'
SELECT dow_admis|
  '
CASE 1
  dow_admis$=" 1 0 0 0 0 0 0"
CASE 2
  dow_admis$=" 0 1 0 0 0 0 0"
CASE 3
  dow_admis$=" 0 0 1 0 0 0 0"
CASE 4
  dow_admis$=" 0 0 0 1 0 0 0"
CASE 5
  dow_admis$=" 0 0 0 0 1 0 0"
CASE 6
  dow_admis$=" 0 0 0 0 0 1 0"
CASE 7
  dow_admis$=" 0 0 0 0 0 0 1"
DEFAULT
  dow_admis$=" 0 0 0 0 0 0 0"
  '
ENDSELECT
'
' ----- Calc # of Diag ----------------------------
'
drg|=0
FOR x%=0 TO 7
  IF MID$(temp$,ADD(108,MUL(9,x%)),1)<>CHR$(48)
    INC drg|
  ENDIF
NEXT x%
'
' -------------------------------------------------
'
opn|=0
FOR x%=0 TO 7
  IF MID$(temp$,ADD(180,MUL(8,x%)),1)<>CHR$(48)
    INC opn|
  ENDIF
NEXT x%
'
' ------ Now put it all together! ------------------
'
temp2$=temp$
MID$(temp$,20,1)=gender$
temp2$=LEFT$(temp$,24)+race$+RIGHT$(temp$,212)
temp$=LEFT$(temp2$,60)+pnt_cat$+RIGHT$(temp2$,192)
```

```
  temp2$=LEFT$(temp$,95)+dow_admis$+dow_dispos$+MID$(temp$,96)
  temp$=LEFT$(temp2$,252)+STR$(drg|)+RIGHT$(temp2$,64)+"  "+STR$(opn|)
  '
RETURN
'
' ==========  FUNCTIONS  ==============================
'
FUNCTION comp_date(date_in$)
  '
  ' Calculates total # of days from 1901 to given Julian Date
  '
  LOCAL year&,julian_date&,comp_date%
  '
  year&=1900+VAL(LEFT$(date_in$,2))
  julian_date&=VAL(RIGHT$(date_in$,3))
  '
  comp_date%=MUL(365,year&)+(DIV(SUB(year&,1),4))+julian_date&
  '
  RETURN comp_date%
ENDFUNC
'
' -----------------------------------------------------------------
'
FUNCTION day_of_wk(comp_date%)
  '
  LOCAL date%,day_of_wk%
  '
  date%=ADD(comp_date%,5)  ! Corrected for start of century
  day_of_wk|=SUB(date%,MUL(7,DIV(date%,7)))+1
  '
  RETURN day_of_wk|
ENDFUNC
'
' -----------------------------------------------------------------
```

APPENDIX C

Regression Analysis

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Appendix C.

List of Tables

Appendix C.

I. DRG 125 - Circulatory disorders except acute myocardial infarction, without complex diagnosis.

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for a functional relationship to the dependent variable LN-LOS.

Table I is an extract of the computer output from Phase I analysis of the PASBA data set. All variables in the equation resulted in coefficient of determination (R^2) of 0.7095. An R^2 of this magnitude indicates that approximately 71 percent of the variability in the dependent variables is explained by the model.

Table I Full Model - Phase I Variables

---- FULL MODEL REGRESSION ----

DRG 125 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30
INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .5510
R SQUARED = .7095

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	25.9503	24	1.0813	3.562	3.296E-04
RESIDUAL	10.6256	35	.3036		
TOTAL	36.5759	59			

To determine the overall significance of this regression equation, a test using the overall F statistic of 3.562 was compared with the critical value at the 5 percent level of significance, $F_{24,35}$, $\alpha = 1.83$. Since the overall F statistic exceeds the critical value the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

However, when examining each of the partial F values of each of the 30 variables in the full model, several do not emerge as significant to the model. To obtain a better model a backward elimination approach was taken using a stepwise regression program.

Independent variables with a partial F of less than 3 were dropped. All of the PASBA variables were eliminated except AGE, A-TUE, PRE-OP, and PROC. Table II is an extract of the computer output from the final stepwise regression

Table II Final Phase I Model

STEPWISE REGRESSION

DRG 125 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30
DEPENDENT VARIABLE: LN-LOS INDEPENDENT VARIABLES: PASBA DATA SET

VAR.	COEFFICIENT	STD. ERROR	F(1, 55)	PROB.	PARTIAL r^2
AGE	.0161	.0048	11.066	.00157	.1675
A-TUE	-.2818	.1527	3.403	.07047	.0583
PRE-OP	.1637	.0194	71.346	.00000	.5647
PROC	.2514	.1319	3.635	.06180	.0620
CONSTANT	-.1667				

STD. ERROR OF EST. = .4807
R SQUARED = .6526

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	23.8685	4	5.9671	25.827	4.480E-12
RESIDUAL	12.7074	55	.2310		
TOTAL	36.5759	59			

program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{1, 55}$, $\alpha = 0.1 = 2.80$. The final regression equation resulted in a R^2 of .6526, slightly lower than the full model. However, the standard error of the estimate was lowered from .5510 to .4807. The final Phase I equation manifested a more significant overall regression equation with an F statistic increasing from 3.562 to 25.827, exceeding the 5 percent level of significance, $F_{4, 55}$, $\alpha = 0.05 = 2.05$.

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 30 variables which effected an overall R^2 of .8831. An R^2 of this magnitude indicates

Table III Full Model - RECORD Data Set

FULL MODEL REGRESSION

NUMBER OF CASES: 56 NUMBER OF VARIABLES: 32 RECORD DATA SET

STD. ERROR OF EST. = .2953
R SQUARED = .8831

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	17.1298	29	.5907	6.776	2.347E-06
RESIDUAL	2.2666	26	.0872		
TOTAL	19.3963	55			

that approximately 88 percent of the variability in the dependent variables is explained by the model. To determine the overall significance of this regression equation, a test using the overall F statistic of 6.776 was compared with the critical value at the 5 percent level of significance, $F_{29,26},\alpha = 1.66$. Since the overall F statistic exceeds the critical value the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

To determine a better equation, the remaining variables were incorporated into a stepwise regression program. Independent variables with a partial F of less than 3 were dropped from the equation. The final model resulted in an equation with six variables. Two variables, PROC and PRE-OP, had been found significant with the PASBA data set. The other variables were LAB, HD, SA, and WB. HD, SA, and WB represented physician providers. Regression coefficients for LAB, PROC, PRE-OP, SA,and WB were positive, indicating a positive relationship with length of stay. HD had a negative regression coefficient indicating an inverse relationship with length of stay. The regression coefficients of the variables are estimates of the magnitude of their

Table IV Final Model - DRG 125

STEPWISE REGRESSION ANALYSIS

VAR.	COEFFICIENT	STD. ERROR	F(1, 49)	PROB.	PARTIAL r^2
LAB	.0369	.0047	62.193	.00000	.5593
PROC	.3330	.0549	36.829	.00000	.4291
PRE-OP	.0951	.0112	72.546	.00000	.5969
HD	-.6307	.2783	5.137	.02787	.0949
SA	.3009	.0966	9.694	.00308	.1652
WB	.4764	.1903	6.269	.01566	.1134
CONSTANT	.5661				

STD. ERROR OF EST. = .2599
R SQUARED = .8294

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	16.0864	6	2.6811	39.690	.000E+00
RESIDUAL	3.3100	49	.0676		
TOTAL	19.3963	55			

association with LN-LOS. Each of the variables had partial R^2 which exceeded the 5 percent level of significance, $F_{1,499}, \alpha = 0.05 = 4.02$.

The final regression equation resulted in a model that explains 83 percent of the dependent variable LN-LOS. The model's R^2 of 0.8294 was slightly lower than the Phase II Full Model (0.8831), but significantly higher than the Phase I Final Model (0.6526). The standard error of the estimate was lowered from 0.2953 to 0.2599. The Null hypothesis for PROC, PRE-OP, LAB, HD, SA, and WB were rejected and the alternative hypothesis was accepted. The null hypothesis for all other variables was accepted.

The final Phase II equation manifested a much more significant overall regression equation with an F statistic increasing to 39.690 exceeding the 5 percent level of significance, $F_{6,499} = 0.05 = 2.29$. The final regression model for DRG 125 is:

LN-LOS = .5661 + (.0369) LAB + (.3330) PROC + (.0951) PRE-OP + (-.6307) HD + (.3309) SA + (.4764) WB

II. DRG 143 - Chest Pain.

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for a functional relationship with the dependent variable, LN-LOS.

Table V DRG 143 Full Model - Phase I Variables

FULL MODEL REGRESSION

DRG 143 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 28

INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .6368

R SQUARED = .6032

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	25.2766	18	1.4043	3.463	4.94E-04
RESIDUAL	16.6280	41	.4056		
TOTAL	41.9046	59			

Table V is an extract of the computer output from Phase I analysis of the PASBA data set. All variables in the equation resulted in coefficient of determination (R^2) of 0.6032. An R^2 of this magnitude indicates that approximately 60 percent of the variability in the dependent variables is explained by the model.

To determine the overall significance of this regression equation, a test using the overall F statistic of 3.463 was compared with the critical value at the 5 percent level of significance, $F_{18,41}, \alpha = 1.87$. Since the overall F statistic exceeds the critical value the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

However, when examining each of the partial F values of each of the 28 variables in the full model, several do not emerge as significant to the model. To obtain a better model a backward elimination approach was taken using a stepwise regression program. Independent variables with a partial F of less than 3 were dropped. All of the PASBA variables were eliminated except PRE-OP and A-TUE. Table VI is an extract of the computer output from the final stepwise regression program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{1, 58}$, = 0.1 = 2.80. The final regression equation resulted in a R^2 of .4514, significantly lower than the full model. However, the standard error of the estimate was lowered from .6368 to .6351. The final Phase I equation manifested a more significant overall regression equation with an F statistic increasing to 23.446 exceeding the 5 percent level of significance, $F_{2, 57}$, $\alpha = 0.05 = 3.16$.

Table VI DRG 143 Final Phase I Model

STEPWISE REGRESSION

DRG 143 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 28

DEPENDENT VARIABLE: LN-LOS INDEPENDENT VARIABLES: PASBA DATA SET

VAR.	COEFFICIENT	STD. ERROR	F(1, 58)	PROB.	PARTIAL r^2
A-TUE	-.4058	.2075	3.825	.05541	.0629
PRE-OP	.2059	.0303	46.059	.00000	.4469
CONSTANT	.9221				

STD. ERROR OF EST. = .6351
R SQUARED = .4514

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	18.9137	2	9.4568	23.446	3.714E-08
RESIDUAL	22.9094	57	.4033		
TOTAL	41.9046	59			

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 30 variables which effected an overall R^2 of .8623. An R^2 of this magnitude indicates that approximately 86 percent of the variability in the dependent variables is

Table VII DRG 143 Full Model - RECORD Data Set

FULL MODEL REGRESSION

NUMBER OF CASES: 58 NUMBER OF VARIABLES: 36 RECORD DATA SET

STD. ERROR OF EST. = .3338
R SQUARED = .8623

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	16.0429	34	.4719	4.235	2.931E-04
RESIDUAL	2.5627	23	.1114		
TOTAL	18.6056	57			

explained by the model. To determine the overall significance of this regression equation, a test using the overall F statistic of 4.235 was compared with the critical value at the 5 percent level of significance, $F_{34,239}$ = 1.93. Since the overall F statistic exceeds the critical value the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

To determine the best equation, the remaining variables were placed into a stepwise regression program. Independent variables with a partial F of less than 3 were dropped from the equation. The final model resulted in an equation with thirteen variables. Table VIII is a extract of the computer output from the stepwise regression program. Only PRE-OP had been found significant in the PASBA data set. The other variables NSDP, CON, DIAG, ER, WB, PB, OA, MA, HD, HA, BB, and BA were obtained from the RECORD data set. WB, PB, OA, MA, HD, HA, BB, and BA represented physician providers. Regression coefficients for all

Table VIII DRG 143 - Final Model

STEPWISE REGRESSION ANALYSIS

VAR.	COEFFICIENT	STD. ERROR	F(1, 44)	PROB.	PARTIAL r^2
BA	.4776	.1829	6.815	.01231	.1341
BB	1.2670	.3058	17.167	.00015	.2807
HA	.2626	.1348	3.791	.05792	.0793
HD	.7262	.1232	34.752	.00000	.4413
MA	.7896	.3125	6.384	.01519	.1267
OA	1.2419	.3060	16.477	.00020	.2724
PB	.8706	.2165	16.163	.00022	.2686
WB	.7464	.1713	18.974	.00008	.3013
ER	.29'3	.0903	10.418	.00236	.1914
CON	-.1182	.0378	9.764	.00315	.1816
DIAG	.0598	.0192	9.693	.00325	.1805
NSDP	.1969	.0893	4.861	.03275	.0995
PRE-OP	.1794	.0191	88.379	.00000	.6676
CONSTANT	.4606				

STD. ERROR OF EST. = .2901
R SQUARED = .8009

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	14.9021	13	1.1463	13.619	2.09E-11
RESIDUAL	3.7035	44	.0842		
TOTAL	18.6056	57			

significant variables except CON were positive, indicating a positive relationship with length of stay. CON had a negative regression coefficient indicating an inverse relationship with length of stay. The regression coefficients of the variables are estimates of the magnitude of their association with LN-LOS. Each of the variables had partial R^2 which exceeded the 5 percent level of significance, $F_{1, 49}, \alpha = 0.05 = 4.06$.

The final regression equation resulted in a model that explains 80 percent of the dependent variable LN-LOS. The model's R^2 of 0.8009 was slightly lower than the Phase II Full Model (0.8623), but significantly higher than the Phase I Final Mooel (0.4514). The standard error of the estimate was lowered from 0.3338 to 0.2901. The Null hypothesis for NSDP, CON, DIAG, ER, WB, PB, OA, MA, HD, HA, BB, and BA were rejected and the alternative hypothesis was accepted. The null hypothesis for all other variables was accepted.

The final Phase II equation manifested a much more significant overall regression equation with an F statistic increasing from 4.235 to 13.619, exceeding the 5 percent level of significance, $F_{13, 49}, \alpha = 0.05 = 1.95$. The final regression model for DRG 143 is:

LN-LOS = .4606 + (.0598) DIAG + (.1969) NSDP + (.1794) PRE-OP + (-.1182) CON + (.2913) ER + (.7464) WB + (.8706) PB + (1.2419) OA + (.7896) MA + (.7262) HD + (.2626) HA + (1.2670) BB + (.4776) BA

III. DRG 132 - Atherosclerosis age >69 and or complications.

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for :. functional relationship with the dependent variable LN-LOS.

Table IX is an extract of the computer output from Phase I analysis of the PASBA data set. The variables in the full model equation resulted in coefficient of determination (R^2) of 0.5724. An R^2 of this magnitude indicates that approximately 57 percent of the variability in the dependent variables is explained by the model.

Table IX DRG 132 Full Model - Phase I Variables

FULL MODEL REGRESSION

DRG 132 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30
INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .5992
R SQUARED = .5724

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	17.7826	22	.8083	2.251	.0142
RESIDUAL	13.2842	37	.3590		
TOTAL	31.0668	59			

To determine the overall significance of this regression equation, a test using the overall F statistic of 2.251 was compared with the critical value at the 5 percent level of significance, $F_{22,37}, \alpha = 1.85$. Since the overall F statistic exceeds the critical value the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

However, when examining each of the partial F values of each of the 30 variables in the full model, several do not emerge as significant to the model. To obtain a better model, a backward elimination approach was taken using the stepwise regression program.

Table X DRG 132 Final Phase I Model

STEPWISE REGRESSION

DRG 132 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30
DEPENDENT VARIABLE: LN-LOS INDEPENDENT VARIABLES: PASBA DATA SET

VAR.	COEFFICIENT	STD. ERROR	F(1, 57)	PROB.	PARTIAL r^2
OTHER	-.8131	.2438	11.123	.00156	.1735
A-THR	-.4522	.1859	5.918	.01839	.1004
D-SAT	.3598	.2024	3.161	.08118	.0563
PRE-OP	.1001	.0293	11.680	.00122	.1806
DIAG	.1166	.0407	8.219	.00593	.1343
PROC	.2551	.1237	4.252	.04413	.0743
CONSTANT	.8723				

STD. ERROR OF EST. = .5540
R SQUARED = .4764

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	14.7987	6	2.4664	8.035	3.45E-06
RESIDUAL	16.2681	53	.3069		
TOTAL	31.0668	59			

Independent variables with a partial F of less than 3 were dropped from the model. All of the PASBA variables were eliminated except OTHER, A-THR, D-SAT, DIAG, PRE-OP and PROC. Table X is an extract of the computer output from the final stepwise regression program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{1, 53}, \alpha = 0.1 = 2.80$. The final regression equation resulted in a R^2 of .4764, significantly lower than the full model. However, the standard error o the estimate was lowered from .5992 to .5540. The final Phase I equation manifested a mor significant overall regression equation with an F statistic increasing from 2.251 to 8.035, exceeding the 5 percent level of significance, $F_{6, 53}, = 0.05 = 2.28$.

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 35 variables which effected an overall R^2 of .8271. An R^2 of this magnitude indicates that approximately 83 percent of the variability in the dependent variables is explained by the model. To determine the overall significance of this regression equation, a test using the overall F statistic of 2.393 was compared with the critical value at the 5 percent level of significance, $F_{34,17,\alpha} = 2.13$. Since the overall F statistic exceeds the critical value, the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

Table XI DRG 132 Full Model - RECORD Data Set

FULL MODEL REGRESSION

NUMBER OF CASES: 52 NUMBER OF VARIABLES: 35 RECORD DATA SET

STD. ERROR OF EST. = .3653
R SQUARED = .8271

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	10.8585	34	.3194	2.393	.0293
RESIDUAL	2.2691	17	.1335		
TOTAL	13.1277	51			

To calculate a better equation, the remaining Phase I variables were used in a stepwise regression program. Independent variables with a partial F of less than 3 were dropped from the equation. The

Table XII DRG 132 - Final Model

STEPWISE REGRESSION ANALYSIS

VAR.	COEFFICIENT	STD. ERROR	F(1, 49)	PROB.	PARTIAL r^2
CON	.0923	.0407	5.149	.02779	.0969
PROC	.2780	.0901	9.520	.00337	.1655
NA	.8066	.3691	4.776	.03377	.0905
CONSTANT	1.5011				

STD. ERROR OF EST. = .3633
R SQUARED = .5174

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	6.7918	3	2.2639	17.151	1.05E-07
RESIDUAL	6.3358	48	.1320		
TOTAL	13.1277	51			

final model resulted in an equation with three variables. Table XII is a extract of the computer output from the stepwise regression program. Only PROC was found to be significant from the PASBA data set. The other variables CON, and NA were obtained from the RECORD data set. NA represented physician providers. Regression coefficients for all significant variables were positive, indicating a positive relationship with length of stay. The regression coefficients of the variables are estimates of the magnitude of their association with LN-LOS. Each of the variables had partial R^2 which exceeded the 5 percent level of significance, $F_{1, 48, \alpha} = 0.05 = 4.04$.

The final regression equation resulted in a model that explains 51 percent of the dependent variable LN-LOS. The model's R^2 of 0.5174 was lower than the Phase II Full Model (0.8271), but somewhat higher than the Phase I Final Model (0.4764). The standard error of the estimate was lowered from 0.3653 to 0.3633. The Null hypothesis for PROC, CON and NA were rejected and the alternative hypothesis was accepted. The null hypothesis for all other variables was accepted.

The final Phase II equation manifested a much more significant overall regression equation with an F statistic increasing from 2.393 to 17.151, exceeding the 5 percent level of significance, $F_{3, 48,} = 0.05 = 2.80$. The final regression model for DRG 132 is:

$$LN\text{-}LOS = 1.5011 + (.0923)\ CON + (.2780)\ PROC + (.8066)\ NA$$

IV. DRG 122 - Circulatory disorders with acute myocardial infarction.

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for a functional relationship to the dependent variable LN-LOS. Table XIII is an extract of computer output from Phase I computer run on the PASBA data set. All variables in the equation resulted in coefficient of determination (R^2) of 0.5806. An R^2 of this magnitude indicates that approximately 58 percent of the variability in the dependent variables is explained by the model.

Table XIII DRG 122 Full Model - Phase I Variables

FULL MODEL REGRESSION

DRG 122 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30

INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .2990

R SQUARED = .5806

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	4.7040	21	.2240	2.505	6.74E-03
RESIDUAL	3.3975	38	.0894		
TOTAL	8.1016	59			

To determine the overall significance of this regression equation, a test using the overall F statistic of 2.505 was compared with the critical value at the 5 percent level of significance, $F_{21,38}$ = 1.84. Since the overall F statistic exceeds the critical value, the null hypothesis can be rejected and it can be stated there is significant regression at the 5 percent level of significance.

However, when examining each of the partial F values of each of the 30 variables in the full model, several do not emerge as significant to the model. To obtain a better model, the backward elimination approach was taken using a stepwise regression program. Independent variables with a partial F of less than 3 were dropped. All of the PASBA variables were eliminated except OTHER, MIL, PROC, PRE-OP and A-THR. Table XIV is an extract of the computer output from the final stepwise regression program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{1, 54}, \alpha = 0.1 = 2.81$. The final Phase I regression equation resulted in a R^2 of .4789, significantly lower than the full model. However, the standard error of the estimate was lowered from .2990 to .2796. The final Phase I equation manifested more significant overall regression with an F statistic increasing from 2.505 to 9.924 exceeding the 5 percent level of significance, $F_{5, 54}, \alpha = 0.05 = 2.39$.

Table XIV DRG 122 Final Phase I Model

-------------------- STEPWISE REGRESSION --------------------

DRG 122 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30

VAR.	COEFFICIENT	STD. ERROR	F(1, 55)	PROB.	PARTIAL r^2
OTHER	.2408	.1348	3.190	.07973	.0558
MIL	-1.1080	.2858	15.032	.00029	.2178
A-THR	.1802	.1030	3.062	.08580	.0537
PRE-OP	.0241	.0082	8.641	.00483	.1379
PROC	.1078	.0338	10.184	.00236	.1587
CONSTANT	2.2304				

STD. ERROR OF EST. = .2796
R SQUARED = .4789

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	3.8795	5	.7759	9.924	9.04E-07
RESIDUAL	4.2221	54	.0782		
TOTAL	8.1016	59			

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 31 variables which effected an overall R^2 of .8687. An R^2 of this magnitude indicates that approximately 87 percent of the variability in the dependent variables is explained by the model.

Table XV DRG 122 Phase II Full Model

———— FULL MODEL REGRESSION ————

NUMBER OF CASES: 59 NUMBER OF VARIABLES: 31 RECORD DATA SET

STD. ERROR OF EST. = .1765
R SQUARED = .8687

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	5.9759	29	.2060	6.614	1.12E-06
RESIDUAL	.9034	29	.0312		
TOTAL	6.8785	58			

To determine the overall significance of this regression equation, a test using the overall F statistic of 6.614 was compared with the critical value at the 5 percent level of significance, $F_{29,299}\,\alpha = 1.86$. Since the overall F statistic exceeds the critical value, the null hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

To determine the best equation, the remaining variables were used in a stepwise regression program. Independent variables with a partial F of less than 3 were dropped from the equation. The final model resulted in an equation with thirteen variables. Table XVI is a extract of computer output from the stepwise regression program. A-THR and PRE-OP had been found significant in the PASBA data set. The other variables SWDP, CON, DIAG, LAB, ADM, HA, RB and SA were obtained from the RECORD data set. HA, RB, and SA represented physician providers. Regression coefficients for all significant variables except ADM, RB and SA were positive, indicating a positive relationship with length of stay. ADM, RB and SA had negative regression coefficients indicating inverse relationships with

Table XVI DRG 122 - Final Model

STEPWISE REGRESSION ANALYSIS

VAR.	COEFFICIENT	STD. ERROR	F(1, 48)	PROB.	PARTIAL r^2
CON	.0234	.0092	6.500	.01403	.1193
LAB	.0069	9.7485E-04	49.562	.00000	.5080
DIAG	.0363	.0112	10.443	.00223	.1787
SWDP	.1808	.0739	5.911	.01808	.1110
ADM	-.0196	.0103	4.500	.03900	.0859
PRE-OP	.0099	.0047	4.501	.03906	.0857
A-THR	.1260	.0584	4.655	.03600	.0884
HA	.1591	.0640	6.185	.01641	.1142
RB	-.2149	.0817	6.914	.01146	.1259
SA	-.72841	.1023	7.706	.00782	.1383
CONSTANT	2.1082				

STD. ERROR OF EST. = .1640
R SQUARED = .8123

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	5.5873	10	.5587	20.771	3.00E-14
RESIDUAL	1.2912	48	.0269		
TOTAL	6.8785	58			

length of stay. The regression coefficients of the variables are estimates of the magnitude of their association with LN-LOS. Each of the variables had partial R^2 which exceeded the 5 percent level of significance, $F_{1, 48}, \alpha = 0.05 = 4.04$.

The final regression equation resulted in a model that explains 81 percent of the dependent variable LN-LOS. The model's R^2 of 0.8123 is slightly lower than the Phase II Full Model (0.8687), but significantly higher than the Phase I Final Model (0.4789). The standard error of the estimate was lowered from 0.1765 to 0.1640. The Null hypothesis for CON, LAB, DIAG, SWDP,ADM, PRE-OP, A-THR, HA, RB, and SA were rejected and the alternative hypothesis was accepted. The null hypothesis for all other variables was accepted.

The final Phase II equation manifested a much more significant overall regression equation with an F statistic increasing to 20.771 exceeding the 5 percent level of significance, $F_{10, 48}$ = 0.05 = 2.03. The final regression model for DRG 122 is:

LN-LOS = 2.1082 + (.0363) DIAG + (.1808) SWDP + (.0099) PRE-OP + (.0234) CON + (.0069) LAB + (-.0196) ADM + (.1260) A-THR + (.1591) HA + (-.2149) RB + (-.2841) SA

V. DRG 014 - Specific cerebrovascular disorders except TIA

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for a functional relationship to the dependent variable LN-LOS.

Table XVII is an extract of the computer output from Phase I analysis of the PASBA data set. All variables in the equation resulted in coefficient of determination (R^2) of 0.3746. An R^2 of this magnitude indicates that approximately 37 percent of the variability in the dependent variables is explained by the model.

Table XVII DRG 014 Phase I Full Model

FULL MODEL REGRESSION

DRG 014 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30

INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .9426

R SQUARED = .3746

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	20.7547	20	1.0377	1.168	.3297
RESIDUAL	34.6513	39	.8885		
TOTAL	55.4060	59			

To determine the overall significance of this regression equation, a test using the overall F statistic of 1.168 was compared with the critical value at the 5 percent level of significance, $F_{20,39}$ α = 1.85. Since the overall F statistic is less than the critical value the null hypothesis is accepted.

However, when examining each of the partial F values of each of the 30 variables in the full model, several emerge as significant. To obtain a better model a backward elimination

Table XVIII Final Phase I Model

STEPWISE REGRESSION

DRG 014 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 30

VAR.	COEFFICIENT	STD. ERROR	F(1, 56)	PROB.	PARTIAL r^2
RET	.4518	.2455	3.386	.07104	.0570
A-MON	-.5123	.2894	3.134	.08213	.0530
PRE-OP	.1017	.0398	6.541	.01328	.1046
CONSTANT	1.5132				

STD. ERROR OF EST. = .8953

R SQUARED = .1898

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	10.5167	3	3.5056	4.373	7.77E-03
RESIDUAL	44.8894	56	.8016		
TOTAL	55.4060	59			

approach was taken using a stepwise regression program. Independent variables with a partial F of less than 3 were dropped. All of the PASBA variables were eliminated except RET, A-MON and PRE-OP. Table XVIII is an extract of the computer output from the final stepwise regression program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{1, 56}$, = 0.1 = 2.80. The final regression equation resulted in a R^2 of .1898, even lower than the full model. However, the standard error of the estimate was lowered from .9426 to .8953. The final Phase I equation manifested a significant overall regression equation with an F statistic increasing from 1.168 to 4.373, exceeding the 5 percent level of significance, $F_{3, 56}$, α= 0.05 = 3.17.

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 36 variables which effected an overall R^2 of .8458. An R^2 of this magnitude indicates that approximately 85 percent of the variability in the dependent variables is explained by the model. To determine the overall significance of this regression equation, a test using the overall F statistic of 3.389 was compared with the critical value at the 5 percent level of significance, $F_{34,21}$, α= 1.99. Since the overall F statistic exceeds the critical value the null

Table XIX DRG 014: Phase I Full Model

FULL MODEL REGRESSION

NUMBER OF CASES: 56 NUMBER OF VARIABLES: 36 RECORD DATA SET

STD. ERROR OF EST. = .4966

R SQUARED = .8458

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	28.4171	34	.8358	3.389	2.26E-03
RESIDUAL	5.1788	21	.2466		
TOTAL	33.5959	55			

hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

To determine a better equation, the remaining variables were incorporated into a stepwise regression program. Independent variables with a partial F of less than 3 were dropped from the equation. The final model resulted in an equation with eight variables. One variable, PRE-OP, had been found significant with the PASBA data set. The other variables were BA, SD, ZIP, ER, CON, LAB, SWDP, and PRE-OP. BA and SD represented physician providers. Regression coefficients for LAB, PRE-OP, SD, ZIP, SWDP and CON were positive, indicating a positive relationship with length of stay. BA and ER had negative regression coefficients, indicating an inverse relationship with length of stay. The regression coefficients of the variables are estimates of the magnitude of their association with LN-LOS. Each of the variables had partial R^2 which exceeded the 5 percent level of significance, $F_{1,47}$, $\alpha = 0.05 = 4.05$.

Table XX DRG 014: Final Model

STEPWISE REGRESSION ANALYSIS

VAR.	COEFFICIENT	STD. ERROR	F(1, 47)	PROB.	PARTIAL r^2
BA	-.5370	.2300	5.449	.02390	.1039
SD	.9807	.4464	4.826	.03301	.0931
ZIP	.2770	.1499	3.414	.07095	.0677
ER	-.4445	.1212	13.447	.00062	.2225
CON	.2510	.0414	36.805	.00000	.4392
LAB	.0323	.0069	22.069	.00002	.3195
SWDP	.4554	.1327	11.786	.00126	.2005
PRE-OP	.0701	.0325	4.666	.03590	.0903
CONSTANT	.6511				

STD. ERROR OF EST. = .4284
R SQUARED = .7432

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	24.9684	8	3.1210	17.002	1.57E-11
RESIDUAL	8.6275	47	.1836		
TOTAL	33.5959	55			

The final regression equation resulted in a model that explains 74 percent of the dependent variable LN-LOS. The model's R^2 of 0.7432 was lower than the Phase II Full

Model (0.8458), but significantly higher than the Phase I Final Model (0.1898). The standard error of the estimate was lowered from 0.4966 to 0.4284. The Null hypothesis for ZIP, ER, CON, SWDP, PRE-OP, LAB, SD and BA were rejected and the alternative hypothesis was accepted. The null hypothesis for all other variables was accepted.

The final Phase II equation manifested a much more significant overall regression equation with an F statistic increasing from 3.389 to 17.002 exceeding the 5 percent level of significance, $F_{8,47}, \alpha = 0.05 = 2.15$. The final regression model for DRG 014 is:

$$LN\text{-}LOS = .6511 + (.0323)\ LAB + (.4554)\ SWDP + (.0701)\ PRE\text{-}OP + (-.4445)\ ER + (.2510)\ CON$$
$$+ (.2510)\ LAB + (.2770)\ ZIP + (-.5370)\ BA + (.9807)\ SD$$

VI. DRG 097 - Bronchitis and asthma age 18-69 without complications.

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for a functional relationship to the dependent variable LN-LOS.

Table XXI is an extract of the computer output from Phase I analysis of the PASBA data set. All variables in the equation resulted in coefficient of determination (R^2) of 0.5344. An R^2 of this magnitude indicates that approximately 53 percent of the variability in the dependent variables is explained by the model.

Table XXI DRG 097 Phase I Full Model

FULL MODEL REGRESSION

DRG 097 NUMBER OF CASES: 60 NUMBER OF VARIABLES: 27

INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .4798

R SQUARED = .5344

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	9.5108	23	.4135	1.796	.0561
RESIDUAL	8.2869	36	.2302		
TOTAL	17.7977	59			

To determine the overall significance of this regression equation, a test using the overall F statistic of 1.796 was compared with the critical value at the 5 percent level of significance, $F_{23,36}, \alpha = 1.83$. Since the overall F statistic is less than the critical value the null hypothesis is accepted.

However, when examining each of the partial F values of each of the 30 variables in the full model, several emerge as significant. To obtain a better model a backward elimination

Table XXII DRG 097: Final Phase I Model

STEPWISE REGRESSION

DRG 09714 NUMBER OF CASES: 56 NUMBER OF VARIABLES: 22

VAR.	COEFFICIENT	STD. ERROR	F(1, 51)	PROB.	PARTIAL r^2
A-FRI	.7800	.1400	29.524	.00000	.3666
D-TUE	.3500	.1700	4.264	.04402	.0772
D-SAT	-.4700	.2400	3.911	.05338	.0712
OTHER	.2800	.1200	4.942	.03067	.0883
CONSTANT	8.309E-02				

STD. ERROR OF EST. = .3200

R SQUARED = .4400

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	4.1400	4	1.0400	9.985	4.80E-06
RESIDUAL	5.2900	51	.1000		
TOTAL	9.4300	55			

approach was taken using a stepwise regression program. Independent variables with a partial F of less than 3 were dropped. All of the PASBA variables were eliminated except A-FRI, D-TUE, D-SAT and OTHER. Table XXII is an extract of the computer output from the final stepwise regression program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{(1, 51)}$ = 0.1 = 2.81. The final regression equation resulted in a R^2 of .4400, even lower than the full model. However, the standard error of the estimate was lowered from .4798 to .3200. The final Phase I equation manifested a significant overall regression equation with an F statistic increasing from 1.796 to 9.985, exceeding the 5 percent level of significance, $F_{(4, 51)}$ α= 0.05 = 2.56.

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 36 variables which effected an overall R^2 of .8280. An R^2 of this magnitude indicates that approximately 83 percent of the variability in the dependent variables is explained by the model. To determine the overall significance of this regression equation, a test using the overall F statistic of 2.757 was compared with the critical value at the 5 percent level of significance, $F_{(35, 20)}$ = 2.02. Since the overall F statistic exceeds the critical value the null

Table XXIII DRG 097: Phase I Full Model

——— FULL MODEL REGRESSION ———
NUMBER OF CASES: 56 NUMBER OF VARIABLES: 57 RECORD DATA SET
STD. ERROR OF EST. = .2840
R SQUARED = .8280

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	7.8100	35	.2230	2.757	9.46E-03
RESIDUAL	1.6190	20	.0810		
TOTAL	9.4290	55			

hypothesis can be rejected and it can be stated that there is significant overall regression at the 5 percent level of significance.

To determine a better equation, the remaining variables were incorporated into a stepwise regression program. Independent variables with a partial F of less than 3 were dropped from the equation. The final model resulted in an equation with ten variables. Two variables, A-FRI and D-TUE, had been found significant with the PASBA data set. The other variables were AA, LA, MA, NA, SC, LAB, SWDP, and CON. LA, AA, MA, NA and SC represented physician providers. Regression coefficients for LAB, A-FRI, D-TUE, NA, MA, SWDP and AA were positive, indicating a positive relationship with length of stay. CON, LA and SC had negative regression coefficients, indicating an inverse relationship with length of stay. The regression coefficients of the variables are estimates of the magnitude of their association with LN-LOS. Each of the variables had partial R^2 which exceeded the 5 percent level of significance, $F_{1,45}$, α= 0.05 = 4.06.

Table XXIV DRG 097: Final Model

STEPWISE REGRESSION ANALYSIS

VAR.	COEFFICIENT	STD. ERROR	F(1, 45)	PROB.	PARTIAL r^2
AA	.3580	.1020	12.304	.00104	.2147
LA	-.6110	.2650	5.324	.02568	.1058
MA	.2880	.1020	7.984	.00701	.1507
NA	.7520	.2410	9.712	.00318	.1775
SC	-.9720	.2290	18.097	.00010	.2868
A-FRI	1.0170	.1000	102.661	.00000	.6952
D-TUE	.6780	.1570	18.688	.00008	.2934
CON	-.2920	.0980	8.933	.00453	.1656
LAB	.0230	5.262E-03	19.397	.00006	.3012
SWDP	.2690	.1190	5.083	.02907	.1015
CONSTANT	-.068				

STD. ERROR OF EST. = .2090
R SQUARED = .7920

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	7.4720	10	.7470	17.181	2.89E-12
RESIDUAL	1.9570	45	.0430		
TOTAL	9.4290	55			

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The final regression equation resulted in a model that explains 79.2 percent of the dependent variable LN-LOS. The model's R^2 of 0.7920 was lower than the Phase II Full Model (0.8280), but significantly higher than the Phase I Final Model (0.4400). The standard error of the estimate was lowered from 0.2840 to 0.2090. The Null hypothesis for D-TUE, A-FRI, CON, SWDP, LAB, SC, NA, MA, LA and AA were rejected and the alternative hypothesis was accepted. The null hypothesis for all other variables was accepted.

The final Phase II equation manifested a much more significant overall regression equation with an F statistic increasing from 2.757 to 17.181 exceeding the 5 percent level of significance, $F_{10, 45}, \alpha = 0.05 = 2.05$. The final regression model for DRG 097 is:

$$LN\text{-}LOS = -.068 + (.023)\ LAB + (.269)\ SWDP + (1.017)\ A\text{-}FRI + (.678)\ D\text{-}TUE + (-.292)\ CON$$
$$+ (.358)\ AA + (-.611)\ LA + (.288)\ MA + (.752)\ NA + (-.972)\ SC$$

VII. DRG 172 - Digestive malignancy age >69 and/or complications.

Variables from the PASBA data set were incorporated into the Phase I Full Model to test for a functional relationship to the dependent variable LN-LOS.

Table XXV is an extract of the computer output from Phase I analysis of the PASBA data set. All variables in the equation resulted in coefficient of determination (R^2) of 0.7977. An R^2 of this magnitude indicates that approximately 80 percent of the variability in the dependent variables is explained by the model.

Table XXV DRG 172 Phase I Full Model

FULL MODEL REGRESSION

DRG 172 NUMBER OF CASES: 48 NUMBER OF VARIABLES: 24

INDEPENDENT VARIABLES: PASBA DATA SET

STD. ERROR OF EST. = .7178

R SQUARED = .7977

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	48.8018	23	2.1218	4.115	5.1E-04
RESIDUAL	12.3750	24	.5156		
TOTAL	61.17687	47			

To determine the overall significance of this regression equation, a test using the overall F statistic of 4.115 was compared with the critical value at the 5 percent level of significance, $F_{23,24}, \alpha = 1.99$. Since the overall F statistic exceeded the critical value, the null hypothesis is rejected and the alternative hypothesis is accepted.

However, when examining each of the partial F values of each of the 24 variables in the full model, several emerge as significant. To obtain a better model a backward elimination

Table XXVI DRG 172: Final Phase I Model

STEPWISE REGRESSION

DRG 172 NUMBER OF CASES: 48 NUMBER OF VARIABLES: 24

VAR.	COEFFICIENT	STD. ERROR	F(1, 51)	PROB.	PARTIAL r^2
RDP	-.6993	.2045	11.696	.00138	.2138
A-THR	.5678	.2534	5.021	.03026	.1046
DIAG	.3337	.0497	45.090	.00000	.5119
PROC	.2463	.0920	7.167	.01047	.1429
CONSTANT	.1222				

STD. ERROR OF EST. = .6992

R SQUARED = .6564

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	40.1544	4	10.0386	20.533	1.61E-09
RESIDUAL	21.0224	43	.4889		
TOTAL	61.1768	47			

approach was taken using a stepwise regression program. Independent variables with a partial F of less than 3 were dropped. All of the PASBA variables were eliminated except A-TUE, DIAG and PROC. Table XXVI is an extract of the computer output from the final stepwise regression program run. Each of the remaining variables had partial F values exceeding a 10 percent level of significance, $F_{1, 43}$, = 0.1 = 2.83. The final regression equation resulted in a R^2 of .6564, lower than the full model. However, the standard error of the estimate was lowered from .7178 to .6992. The final Phase I equation manifested a significant overall regression equation with an F statistic increasing from 4.115 to 20.533, exceeding the 5 percent level of significance, $F_{4, 43}$, α= 0.05 = 2.83.

The significant Phase I variables were then incorporated into a full regression model containing the RECORD data set. The Phase II full model consisted of 34 variables which effected an overall R^2 of .9074. An R^2 of this magnitude indicates that approximately 91 percent of the variability in the dependent variables is explained by the model. To determine the overall significance of this regression equation, a test using the overall F statistic of 3.747 was compared with the critical value at the 5 percent level of significance, $F_{34, 13}$, α= 2.37. Since the overall F statistic exceeds the critical value the null

Table XXVII DRG 172: Phase I Full Model

FULL MODEL REGRESSION

NUMBER OF CASES: 48 NUMBER OF VARIABLES: 36 RECORD DATA SET

STD. ERROR OF EST. = .6603

R SQUARED = .9074

ANALYSIS OF VARIANCE TABLE

SOURCE	SUM OF SQUARES	D.F.	MEAN SQUARE	F RATIO	PROB.
REGRESSION	55.5559	34	1.6340	3.747	7.01E-03
RESIDUAL	5.6686	13	.4360		
TOTAL	61.2244	47			

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