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An Examination of Relationships Among Indicators of Socioeconomic Status, Health Status, and Selected Health Care Utilization for Fund Allocation

by

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Dedication

This thesis is dedicated to Sara Boles and Matthew Boles, two very special people.

ABSTRACT

Given the current movement to regionalization and population needs based funding in health services, it has become necessary to measure resource need to adjust health budgets beyond an age-sex per capita allocation.

Most existing models for measuring health need have used per capita rates of mortality and morbidity as either dependent measures, or as independent measures for association with utilization. While this epidemiologically oriented approach is both logical and popular, such measures do not translate well into resource need measures. In modern industrial societies, utilization has shifted from cure aspects to care aspects of health; and socioeconomic status (SES) has become recognized as an equally important indicator of health status, and determinant of utilization.

An exploratory small area analysis was conducted to determine relationships among socioeconomic status, standardized mortality ratio, and selected health care utilization rates in the Alberta population. Acute care hospital cases, purposely selected to reduce professional uncertainty in the data, were used to develop a proxy measure of health resource need.

Areas, with a high percentage of poorly educated population, low income, and high aboriginal component, were found to both use and need a greater degree of health resources relative to other areas. Areas with high unemployment were found to use less resources but appeared to need more.

Predicted values from small area regression analysis were converted into an SES Relative Value Scale to adjust budget allocations among regional health authorities in Alberta. The result would be a re-allocation of about 4.6 percent of the total regional health budget beyond an initial allocation by age-sex adjusted per capita. Some health regions, with high aboriginal and poorly educated populations, would gain substantially. On the other hand, these same regions tend to not benefit from age-sex adjustment due to the lower lifespan of their aboriginal populations. Some regions tend to receive less in relation to their historic utilization patterns. Thus a transitional mechanism, also provided in the study, may be required in moving to a needs based funding model.

This study provides only the SES adjustment portion of a population needs based funding model. Age-sex adjusted populations, weighted by recent utilization rates at the provincial level, would need to be calculated each budget year. Additionally, policy would need to be in place for cross-region utilization, and for providing service in remote areas.

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CHAPTER I

INTRODUCTION

1.1 Purpose

The purpose of this thesis is to examine the relationships among measures of socioeconomic status (SES), health status, and health service utilization, using small area analysis. The relationships found would then be used to develop a needs based model to explain health need and health service utilization patterns across geographic areas, including Alberta health regions. The implications of using such a model for the allocation of resources beyond an age-sex adjusted per capita approach would then be examined.

1.2 Background

There is currently a movement to spend health care dollars more efficiently and effectively, place greater emphasis on prevention, focus on need as opposed to past utilization, and allocate funds on a regional basis. This movement has resulted in various attempts to find valid indicators of the level of health need in a population. Some attempts have also been made to convert these population-based measures of need into mechanisms for allocating funds. The three commonly accepted variables for allocating funds have been the size of the population and composition of age and gender. Utilization rates (by age-sex groups) at the highest geographic level (eg. provincial level) are used to derive relative weights for the age-sex groups.

The Alberta Government is moving in the direction of age-sex adjusted per capita allocation, which may result in a fairer share of funds across regions and municipalities (Geddes, 1995). This direction may be prompted both by the pressure of significant budget reductions as well as the role the government must play in allocating limited funds in a fair manner to the semi-autonomous Regional Health Authorities. While this movement would be seen as a step forward, the literature suggests it is also appropriate to adjust by standardized mortality ratio (SMR) and/or socioeconomic status (Carr-Hill & Sheldon, 1992; Frohlich, et. al., 1994; Eyles, et. al., 1994; Carstairs, 1995).

Basic measurement problems to date have been:

(1) the matching of data to appropriate geographic areas for aggregation and analysis,

(2) selection of the most valid SES variables,

(3) limitations in using SMR beyond specific types of patient groups, and

(4) selection of a dependent measure for predicting need that has close association with resource use.

Past utilization, as a valid dependent measure, has been criticized due to the inherent bias contained in the data. The bias is primarily due to professional uncertainty in decision making by physicians, physician practice style, and availability of services in the particular community. This tends to result in the inclusion of what has been considered unnecessary and inappropriate service in utilization data.

Standardized Mortality Ratio (SMR) is viewed by some researchers as the best available indicator of health status and proxy measure of health need in a geographic area (Eyles & Birch, 1993). SMR is apparently the only variable currently used to adjust funding (beyond age-sex per capita) to Britain's regional health authorities (Carstairs, 1995). As a measure that can be used to convert need into resource allocation, its value is controversial. For funding allocation purposes, its importance is losing ground to measures of SES (Carstairs, 1995; Frohlich, et. al., 1994).

Conceptually, SMR, SES, and utilization each reflect the level of health need in a population. They are not measures of specific need that can point to specific types of interventions, including early intervention and prevention initiatives. This would require the use of large-scale surveys across the geographic areas of interest. While the survey-based approach may be more likely to reveal relationships among health status, utilization and SES, it is a resource intensive methodology due to the large samples required to make comparisons at a regional level. Further, there is usually a time lag in obtaining results and some measurement problems exist. For example, survey respondents may experience difficulties in identifying, from a nonmedical perspective, exact procedures and diagnosis they received.

1.3 Objectives

Specific objectives of this thesis are:

(1) to determine the degree of association between common SES variables and SMR;

(2) to determine the degree of association of SES (as well as SMR) with selected utilization measures;

(3) to develop a model for predicting health resource need; and,

(4) to develop a procedure for applying the above model for fund allocation adjustment beyond age-sex adjusted per capita.

1.4 Significance of the Study

Overall, this thesis replicates studies conducted in the provinces of Manitoba, Ontario, and British Columbia, and critiques the variables used. This thesis also takes a significant step forward by using a form of unbiased utilization as a measure of need, and by applying SES variables directly to the measure of need.

Most studies to date have focused on using SMR or SES to explain health status, but have not taken the subsequent step of projecting a possible re-allocation of resources based on the measure of need. Studies that use measures of utilization have not attempted to remove bias due to unnecessary utilization from the data. Studies that have projected a re-allocation of resources have generally not based the relative weights for the geographic areas on a regression model. A regression model simultaneously determines the most accurate relative position of each area.

This study contributes to the scientific development of small area analysis and funding models by addressing the above issues, and by developing an SES Relative Value Scale for Need to directly adjust allocations following an age-sex adjusted per capita allocation. In determining the appropriate geographic unit for small area analyses, the study helps establish a balance between the need for a large number of areas to capture variation, and a small enough number to ensure population size per area is large enough to provide stable estimates of rates and percentage values for use in a statistical model.

The study is, of necessity, exploratory as little work has been done in this area specific to prospective formula based funding models, especially models that define need in terms of unbiased utilization.

1.5 Relevance of the Study

The study will have relevance to health service planning and administration, and should provide direction for health policy formulation in allocating resources. Alberta Health has been developing a population needs based funding model based on an age-sex adjusted basis. As Eyles and Birch (1993) have noted, applying the same age-sex specific utilization ratios to all geographic areas, with wide variation in socioeconomic status, may result in under serving areas with low socioeconomic status. This potential problem is particularly important in the current health services environment as funds are being reduced significantly and regionalization requires a population-based, verifiable formula for health fund allocation.

1.6 Ethical Implications

For studies using utilization data, the basic ethical concern is that the identity of individuals, and information about their health, remain absolutely confidential, and confidentiality be guaranteed.

This thesis had no interest in data at the individual and family level. It used small geographic area, as opposed to the individual, as its unit of analysis. All sources of data, including hospital abstract files, vital statistics death files, and census data files have no personal identifiers.

1.7 Organization of Thesis

The thesis is organized into five chapters. Chapter I provides the purpose, background information, objectives to be reached, and the relevance and significance of the thesis to the area of health services administration.

Chapter II provides an overview of the literature, divided into seven sections, each specific to an area important to the content and methodology of this study. These areas include the concept of socioeconomic status (SES) and selection of SES variables, health status and standardized mortality ratio (SMR), an understanding of professional uncertainty in medical decision making and unnecessary service, the use of health care utilization data in research, the special role played by RDRGs (Refined Diagnosis Related Groups) and related hospital case weights, and literature specific to small area analysis for developing funding models.

Chapter III describes the methodology used, including data sources, considerations in developing the research design, steps taken in carrying out the methodology, including matching and aggregating of data from various sources, selection of cases based on a high degree of professional certainty to hospitalize, definition and selection of SES measures, statistical procedures, and, development of SES relative value scales using utilization and selected utilization data. Methodological limitations of the study are also contained in Chapter III.

Findings and interpretations are contained in Chapter IV. Included are descriptive statistics, bivariate associations, statistical output from multiple regression analyses, interpretation of findings, models developed for predicting standardized resource utilization rate (SUR) and standardized resource need rate (SNR), the SES Relative Value Scales and their application to Alberta Health Regions. Estimates are made of the financial impact of using the SES Relative Value Scales.

In Chapter V, a summary of the thesis is provided, conclusions are drawn, and recommendations made for fund allocation policy and for further research and refinement of the model.

CHAPTER II

LITERATURE REVIEW

2.1 Scope of Review

The author of the thesis examined selected articles, books, and published reports primarily from Canada and Britain. Most literature was from the 1990's, with some items dating back to the mid-1980s. Literature was examined across five main subject areas: SES and health need, health service utilization, small area analysis, standardized mortality ratio (SMR), and fund allocation models. Most studies examined involved at least two of these five subject areas.

2.2 Findings

Findings from the literature review are arranged into seven sections. These are followed by summary and conclusion sections.

2.2.1 Socioeconomic Status (SES):

Eyles and Birch (1993) state the relationship between SES and health status has been found using various forms of measurement, across time, across geography, life cycle, and causes of illness. They point to numerous studies linking health status measures (morbidity, mortality, self-reported health status) with the commonly used SES variables of income, education, and occupation. They further note that SES variables remain correlated with health status after controlling for age and sex as well as life-style behaviours. It is significant to note, however, that while

SMR has been described as the "best" available predictor of health status and need in a population (Eyles and Birch, 1993), Frohlich, et. al. (1994) found measures of SES collectively tended to have explanatory value beyond SMR.

Hertzman, et. al. (1994), present an argument for not viewing SES as having a direct relationship to morbidity, but instead viewing the relationship as "generalized vulnerability." They claim that looking for links with morbidity may limit the value of SES for health. They indicate that British data have shown, over many decades, an association between mortality and SES, even though the causes of death (morbidity) have changed. Hertzman points to cohort studies that have controlled for lifestyle differences and have still shown a relationship between health status and SES.

An analysis and interpretation of the health component of the 1991 General Social Survey (Roberge, et. al., 1995), provides an example of the value of the survey-based approach to measuring SES and health need in a population. The survey found the expected age and gender differences in health but also found adults with low household income, low educational attainment, low-skilled occupations, and being unemployed tend to have poorer health than other adults. Roberge also noted that other health surveys, in particular the Health Promotion Survey of 1990, found adults in low income households more likely to be daily smokers, and less likely to quit smoking, more likely to use tranquillizers and sleeping pills, and less likely to know some of the causes of heart disease as well as the prevention measures for sexually transmitted diseases.

While the causal relationship between socioeconomic status (SES), health status, and health care utilization is not clear, the fact that there is an association among the three is clear in the literature. Benzeval et. al. (1995) have postulated that SES (or deprivation) and demographic factors impact upon lifestyle which then impacts upon health status.

2.2.2 Selection of Socioeconomic Variables

Regarding specific variables for measuring income, Libertos (1988) addresses the importance of incorporating family size (such as by using established poverty lines). For average and low income families, family size may have a significant impact on purchasing power. Poverty lines for this thesis are the Low Income Cut-Off levels (LICOs) developed by Statistics Canada according to average income spent on basic needs, degree of urbanization, and number of persons in the family. They are adjusted each year. The Health Status of Canadians report (Statistics Canada, 1994) recognized the need to adjust income by family size. In the report, poverty lines were used as a basis for adjustment. Frohlich and Mustard (1994), using Manitoba data and a small area analysis, did not find average income to be a statistically significant indicator for their SES index.

Frohlich and Mustard (1994) found unemployment rate correlated strongly with their index of health status using an analysis at the municipal and health region level in Manitoba. Roberge, et. al. (1995), also noted this association at the level of the unemployed individual.

Frohlich and Mustard (1994) also used mean dwelling value as a major component of their SES model. However, with a small area analysis, the author of this thesis believes this measure is likely to also reflect the value of real estate across a province.

Differences in both SES and health status have been shown to be extreme between aboriginal and non-aboriginal people (British Columbia, 1994). The B.C. report states that it is the SES variables associated with aboriginal status that are the variables of importance. This postulate is suggested as well by some American researchers (Benzera, et. al., 1995). The size of the aboriginal component across small areas may therefore act as a significant intermediate variable for SES in Canada.

In Britain, many indices of SES (or the related concept of deprivation) have been developed for association with health need and, more specifically, for association with mortality and morbidity. Many include the measure of single parent status. Carstairs (1995) assessed a number of these indices and concluded that, since they rely on making a link between mortality and/or morbidity, they are epidemiologically based. She notes that analyses of SES in relation to resource need, which may be more appropriate for the purpose of developing a population-based regional funding model, are sparse.

Jones (1995) notes that deprivation indices vary widely in the specific measures they use and the statistical techniques involved. While Jones found very high correlations among a number of census-based indices, they displayed wide variation in the actual small areas they selected as being the most deprived. It is noteworthy that Jones found high correlations between the various deprivation indices and the single British census measure of "households with no car." He notes that some authors recommend a single measure of deprivation as it is unambiguous, transparent and avoids the methodological problems associated with indices.

However, the author of this thesis did not find a study that developed a model with only one measure of SES or deprivation. Health status, on the other hand, is often measured with only one variable.

2.2.3 Health Status and Standardized Mortality Ratio

Although there is no theoretical basis for selecting age 75 as the cut-off point, SMR for the less than 75 year age groups has been used as a measure of the rate of premature death in a population (Eyles & Birch, 1993; Eyles, et. al., 1994; Frohlich et. al., 1994). It is considered a valid measure of health status and indicator of morbidity in a geographic area.

Frohlich et. al. (1994) found a high correlation between a health status index (created largely from measures of morbidity) and SES variables. The correlation reduced only marginally when all-cause SMR (<75 years) was used instead as the measure of health status. However, the author of this thesis contends that the strong association found between SES and SMR (<75 years) may have been due to the way the SES index was developed. It was developed by weighting each SES variable according to its degree of association with the health status index. Thus, the resulting SES index would then be a mixed index of SES and health status, and would have an inherent bias for association with all-cause SMR (< 75 years).

The problem with SMR is that although it is a well-accepted proxy measure of morbidity, and therefore health need, it does not necessarily translate into a measure that reflects resource need. Modern societies expend major portions of their health care resources on care aspects as opposed to cure, or life saving, aspects. Further, it has been known that SMR is a relatively volatile measure subject to high variation from year to year, especially when small geographic areas are involved as the number of deaths is relatively small.

2.2.4 Health Care Utilization

Frohlich & Mustard (1994) and Frohlich, et. al. (1994), analyzing Manitoba data across geographic areas, have confirmed that Canadian acute and ambulatory care utilization rates tend to have an association with SES variables. Frohlich's studies also found a relationship between SMR, SES and health care utilization at the health region level. Regions with poor SES experienced higher mortality rates and had higher utilization rates of health services than regions with more favourable SES. These regions had more short-stay hospital visits and more primary care visits. A recent British Columbia Government report (1994) also supports these findings. The above studies found that a high level of hospital utilization did not act as a substitute for physician utilization. The above studies concluded that, if high risk areas also have high levels of utilization, the additional utilization may not be having an impact on the health of the populations. Analysis at the level of the individual (Roberge, 1995), as compared to small area analysis, also found that individuals with lower SES, in particular poor education and low income, utilize health services more than individuals with a high level of education and income.

Variation in utilization of health services among geographic areas is also explained by variables other than SES. Urbanization has been recognized as one such additional variable. Black, et. al. (1993) analyzed the utilization of hospital services in Manitoba, and found acute care utilization rates to be considerably higher for non-Winnipeg than Winnipeg residents. Hospital utilization for chronic care however revealed the reverse pattern. The most recent B.C. Government report (1995) on the health status of the B.C. population identifies wide variation in age standardized rates between urban and rural health regions. The report also shows wide variation among regions for all major health services.

Numerous studies have used specific types of acute care cases to analyze variation between areas (Andersen & Mooney, 1990). Few, if any, have used ambulatory cases. Andersen and Mooney (1990) noted that variation in utilization and physician practice patterns may have many causes: the physician's judgement of outcomes and utilities for the patient, availability of services, and physician incentives. They maintained, however, that professional uncertainty in decision making is the factor having the most impact.

2.2.5 Professional Uncertainty and Related Issues

Research that involves measures of utilization, such as this thesis, must account especially for the inherent element of professional uncertainty in the data. In the early development of Diagnosis Related Groups (DRGs) in the 1960s, professional uncertainty by physicians was a problem to consider:

> Some diseases physicians know very well and there is consensus, at least locally, as to how they ought to be treated. The treatment of many diseases, however, varies among physicians. (Fetter, 1991, 11)

Eddy (1984), with his very thorough description, provides an appreciation for professional uncertainty in decision making by physicians. He notes that it plays a role from defining the disease or illness, to diagnosis, to treatment, and outcome. Eddy states that in defining an illness physicians rely on the presenting symptoms; but for many illnesses, symptoms are difficult to recognize, which can result in missing an existing disease or "finding" one that does not exist. He provides the examples of dysplasia of the cervix, obesity, hyperplasia of the tonsils, fibrosystic disease of the breast and others. He states that some diseases are defined because they precede a real disease such as ocular hypertension and glaucoma. As well, signs, symptoms, findings, and conditions that result in a diagnosis are "extremely common." Eddy notes that modern technology tends to increase uncertainty for physicians as it collects data earlier in the episode of illness and the decision making process.

Even when there is no uncertainty surrounding definition of a disease, physicians may vary widely in the procedures followed in making the diagnosis.

Variation occurs in their asking of questions, observing signs, interpreting test results, and recording answers (Eddy, 1984, p.77). Eddy reminds us that once a physician is provided with test results, or his/her own findings, he/she is left with a set of probabilities on which to base a decision. Each test or finding must be considered against its predictive probability.

Eddy concludes that similar illnesses or conditions have a likelihood of being treated differently. If all the uncertainties resulted in random variation throughout a population of physicians and patients then these differences would average out across geographic regions. However, he notes that physicians tend to make decisions similar to those in their geographic community.

Andersen & Mooney (1990), drawing on the work of Wennberg, note that standardized utilization rates for specific types of hospital cases vary according to the complexity and severity of the case such that cases of greater severity and complexity exhibit less variation. They note that hospital cases with greater complexity and severity are associated with less professional uncertainty.

Analysis of variation in utilization rates for health services in Manitoba (Black, et., al., 1993), used categories of acute care cases developed by Wennberg. The analysis also determined that cases at the highest level of intensity and complexity showed the lowest variation in standardized utilization rates. Specific types of ambulatory cases were not selected for analysis.

The most recent B.C. Government report (1995) on the health of its population noted that, for similar case mix groups, ratios of highest to lowest hospital admissions across health regions can be as high as 7:1.

Given the above findings, It might be assumed that the relationship between complexity/severity and professional uncertainty for acute care cases would hold for other areas of health services. It might also be assumed that the complexity and severity of cases in acute care overall would display less uncertainty than cases in other areas of health service such as ambulatory care and long term care. Appropriate selection of those acute care cases with high complexity/severity, and appropriate units of utilization to use for measurement, would remain important considerations.

2.2.6 Hospital Case Weights as Measures of Resource Utilization

Case mix categories such as CMG (Case Mix Groups), DRGs (Diagnosis Related Groups), ADRGs (Adjacent Diagnosis Related Groups), and RDRGs (Refined Diagnosis Related Groups) have been developed to group illnesses for the purpose of estimating resource consumption. Case weights, or "relative costs" have been developed for each of the grouping systems in order to provide prospective payment (DRG for United States) or to assess resource consumption (CMG for Canada). Weights have yet to be developed for ambulatory care and long term care. For research purposes, these case mix groupings provide the capacity to retrospectively select hospital cases.

DRGs were developed and refined over a twenty year period, beginning in the 1960s (Fetter, 1991), but each development failed to account precisely for levels of severity of illnesses. Health Systems Management Group (1990) conducted a major revision of DRGs, which resulted in the development of the ADRG and RDRG categories. Under this model, a case is first assigned to one of 23 Major Diagnostic Categories (MDCs) based on the principal diagnosis. Except for "temporary tracheostomy" and "early death" a case is then assigned to a surgical (Operating Room Procedure) or medical subgroup. The subgroups are the ADRG categories. RDRG categories are determined according to four levels of severity for surgical procedures and three levels of severity for medical treatment. Appendix A displays the classification system schematically (Health Systems Management Group, 1990).

Refined Diagnosis Related Group Weights (RDRGWs) provide the case weights associated with RDRG categories to estimate resource use (Health Systems Management Group, 1990; Jacobs, Bay & Hall, 1993). While RDRGs were developed in the United States they are used to some extent in Canada, especially in Alberta, with weights developed using U.S. charge data and adjustments for Alberta length of stay. The assumption is made that while the resources used per specific illness and procedure may differ between Canada and the United States, the relative values between them should be similar. An initial version of RDRGWs was developed for Alberta Health in 1989, by Mckenzie of Queen University, but the version contained a number of weaknesses that created controversy for those impacted by their use. Jacobs, Bay and Hall (1993) developed a new version to help rectify these weaknesses, which included:

(1) unnecessary complexity in their development which prevented a capacity to evaluate the accuracy of the weights.

(2) the per diem weights had been determined by dividing case weights by the Alberta average length of stay (ALOS) for each category. This approach did not allow for differentiation between the fixed cost and variable cost components involved. The average fixed cost was applied to each day over the episode of treatment. Yet the fixed cost element should not apply to all patient-days in an episode of treatment. Marginal cost (generally accepted as variable cost) becomes appropriate for cases that involve days beyond generally accepted end points.

(3) Errors in accounting for the special high cost cases of tracheostomies and low cost cases of early deaths was evident.

The authors used Maryland State hospital separation abstract files for 1990 and 1991 to provide a set of actual case charge data. Actual charge data was available on the abstract files to allow an estimate of fixed and variable costs for each RDRG category. The authors calculated average inlier case values using the average fixed and average variable cost for each RDRG category. For day values, to estimate additional outlier costs, only estimated average variable cost was used. Outlier cases are those with length of stay beyond the commonly accepted outlier cut-off points of the 75th percentile plus two times the inter-quartile range of ALOS for each RDRG category. Two sets of weights were generated. Option A weights used all cases, including outlier cases, to derive the case weights. Option B weights used inlier cases only (for the case weights).

Regarding the two other common units of measure for acute care, hospital separation or admission rates, and hospital patient-day rates, these measures are a poor reflection of actual resource use as they do not incorporate the variation in resource use among different hospital cases. Case mix categories and related case and day weights are necessary in acute care resource measurement for two basic reasons. Unlike U.S. hospitals, Canadian hospitals do not maintain patient accounts to reflect the cost for serving each case. Actual costs for a hospital case cannot be readily accounted for as various departments are drawn upon to provide resources for each case. The Canadian Institute for Health Information (CIHI) notes that admissions can depend on the role of the acute care hospital in the area and availability of alternate treatments (1995). Jacobs (1992) notes that length of stay can be influenced by hospital admission criteria and funding considerations. Thus although current methodology for case weight development has weaknesses, especially the lack of available Canadian data, case weight is the only option left to measure resource use in Canadian hospitals.

2.2.7 Small Area Analyses and Funding Models

Small area analysis has been used in Canada to compare per capita hospital utilization rates (Bay & Nestman 1984), to assess utilization (Frohlich, 1994; British

Columbia, 1994), to identify inappropriate use of service (Roos & Roos, 1992) and to measure the need for health, including its association with SES (Frohlich, et. al., 1994; Evans et. al., 1994). Some movement in using small area analysis for funding models is evident in Canada (Eyles et., al., 1994; Eyles & Birch, 1993).

Britain has had experience developing funding models for its regional health authorities. As described by Mays et. al. (1992), and Carstairs (1995), Britain developed the Resource Allocation Working Party (RAWP) formula in 1977 to distribute resources to regional health authorities. The above researchers state that the initial formula was based on weights for age-standardized bed-use and weights based on SMRs. The theory was that since the approach was utilization-based, it reflected resource use; and with SMR included, it also accounted for morbidity (a commonly accepted measure of health need). The authors note that subsequent reviews of the formula have resulted in recommendations to decrease the weight attributed to SMRs and incorporate a measure of SES or deprivation into the model. The reviews noted that SES had explanatory power over and above SMR (Carstairs, 1995).

Carr-Hill & Sheldon (1992) are critical of the most recent, modified, funding formula used in Britain as they claim it uses all-cause SMR (<75 years) alone, yet does not use an actual prediction (statistical) model. The authors are not critical, however, of using utilization rates for measurement as they reflect current use and service patterns. They refer favourably to a model that uses activity rates in acute and non-acute care with age and SES (deprivation) adjustments.

In Canada, recent work by Eyles and Birch (1993) presents a methodology for applying population needs-based measures to fund allocation. They use specific types of SMR for some services and all cause SMR for others, and allocate to specific geographic areas in relation to the overall utilization of health services in Ontario. They do not develop a predictive statistical model based on relationships between SMR and utilization across all geographic areas simultaneously in order to find the best statistical fit, and they do not incorporate major measures of SES.

2.3 Summary of Findings

The major findings from the literature review are:

(1) Income, education, occupational status, unemployment, aboriginal status, and single parent family, appear to be the major SES variables used in developing population needs based funding models.

(2) The literature shows value in using SMR as a proxy for health need associated with morbidity, but indicates that SMR may not necessarily reflect health need associated with resources.

(3) When the purpose of the research is to measure and predict resource need specifically, the literature tends to support the use of measures of utilization.

(4) Some researchers are critical of using utilization data for measures of need due to the bias contained in the data. The bias is due largely to professional uncertainty in decision making. It is argued that using utilization data to

measure need may tend to perpetuate any current inequities in health care access and funding.

(5) Given the elements of professional uncertainty, practice style, and the other confounding factors, utilization data should not be considered in their original form.

(6) Acute care hospital utilization data may provide the most appropriate cases to use in obtaining a proxy measure of need due to their apparent lower likelihood of professional uncertainty as compared to outpatient services or long term care.

(7) Regarding units of utilization, many studies have used admission rates or patient-days, and have grouped services at a broad level. Studies that do focus on comparing specific cases have been limited to surgical and medical acute care services. However, these studies have been able to clearly demonstrate an association between variation in utilization rates and degree of complexity and severity of the case. Cases of higher complexity and severity display lower variation in utilization. Some researchers have attributed this to the degree of professional uncertainty involved in decision making.

(8) ADRG categories provide for the possible selection of acute care hospital cases. RDRGWs provide resource units that are more accurate than hospital patient-days, hospital admissions, or physician visits.

(9) While many studies have developed the link between SES, health need, and utilization, few have taken the step of developing a predictive funding model based on this association, or attempted to factor out the bias of professional uncertainty.

2.4 Conclusions

For fund allocation models, need must be measured through units of utilization as opposed to an epidemiological approach. Acute care cases, standardized for age and gender, may be the most appropriate to draw on to develop a measure of resource-based need. ADRG case mix categories may provide a possible means for selecting hospital cases of high certainty to hospitalize and low level of possible unnecessary service.

RDRGW rates may provide a more valid and accurate measure of resource utilization and need than patient-days or admissions and may result in close association with both SES variables and SMR (< 75 years). SES variables may provide a stronger association for model development than SMR.

A number of methodological challenges were apparent from a review of the literature: The selection of SES variables, the selection of a valid proximal dependent measure of resource-based need, accounting for professional uncertainty and possible unnecessary service, selection of specific small areas to use for analyses, aggregation of data to various geographic levels, and development of statistical models and appropriate weights or relative values to be applied.

CHAPTER III

METHODOLOGY

To meet the purpose and specific objectives of the study, sources of data had to be identified, a number of design considerations needed to be resolved, and five basic methodological steps needed to be carried out. Following an introduction, the design considerations and details of the five steps are described in this chapter.

3.1 Introduction

The thesis is a retrospective exploratory study. Secondary data sources were used to explore the development of a measure of unbiased utilization and its association with SES variables and SMR. Reproducibility of the outcomes of the thesis was a major focus. It was intended that outcomes would provide a model that can be used over time and across jurisdictions as a formula for budget allocations among health regions.

A number of relatively recent developments allowed the current study to be undertaken, including:

(1) the acceptance at this time of all-cause standardized mortality ratio (especially the < 75 year age groups) as one measure of health status and indicator of health need in a population;

(2) the recent work by Frohlich & Mustard (1994), and others, drawing on Canada Census data to provide some significant measures of socioeconomic status across geographic areas that associate with SMR and utilization;

(3) the current availability of RDRG categories on the Alberta hospital abstract files; and the associated case and day weights developed by Jacobs, Bay and Hall (1993);

(4) the incorporation of postal code information into the hospital separation abstract, and other, data files, allowing units of utilization and deaths to be matched to a patient's geographic area of origin, and be matched to census geo codes.

3.2 Data Sources

The major sources of data for this study are the 1991 census data, hospital separation abstract files, and vital statistics death files.

3.2.1 1991 Canada Census

Population counts by five-year age group were selected from the Statistics Canada 2A Profile data base for each enumeration area (EA) in Alberta. Socioeconomic variables were selected from the Statistics Canada 2B Profile data base also by EA. Thus EA constitutes the basic geo code and unit of record for demographic and socioeconomic files.

3.2.2 Hospital Separation Abstract Files

Hospital Separation Abstract Files were accessed for the calendar years 1990, 1991 and 1992. The data for all acute care hospitals in Alberta were selected.

Postal Code, length of stay (LOS), RDRG code, age and gender were the variables selected.

3.2.3 Vital Statistics Death Files

Vital statistics death records were extracted from the 1990, 1991, 1992 Vital Statistics Death Files. The variables selected were age, sex, and postal code.

3.2.4 RDRG Weight Tables

RDRG case weights developed by Jacobs, Bay & Hall (1993) were used to estimate relative resource consumption for each record in hospital separation files.

3.3 Design Considerations

A number of considerations were necessary in developing the research design for the study. These included basic threats to validity, selection of appropriate small areas, and accounting for unnecessary utilization.

3.3.1 Questions of Validity

From a research methodology perspective, the use of small geographic area (as opposed to the individual) as the unit of analysis can be a threat to validity. This threat to validity is described by Libertos (1988) as the ecological fallacy. It is argued that averages of variables from small areas cannot adequately represent the needs of each of the individuals in the area. Therefore, for this study, the implication is that the findings are only valid at a geographic level. One major reason for using an ecological model is the availability of data. No data set is currently available which contains individual level demographic, socioeconomic, and health care utilization with linkable identifiers. Thus the use of geographic area as a unit of analysis is primarily due to data limitation. If Alberta Health collected data for key SES variables on its insurance registry, an ecological model would not be necessary.

Utilization, as a measure of resource need in this thesis, was also a concern to validity largely due to the confounding element of professional uncertainty, variation in practice style, and availability of services.

Yet some form of utilization is the only available dependent variable to use in a model that associates health need with relevant variables for the specific purpose of fund allocation. As noted in Chapter II, it seems inappropriate to use a measure of SMR, or other measure of health status, as either an independent or dependent measure to indirectly predict resource need. It may be appropriate, however, to associate SES directly with a measure of unbiased utilization. Even if SMR tends to serve as a proxy for morbidity, morbidity is not necessarily a proxy for resource-based need. As noted in Chapter II, the link between SMR and health need, especially resource need, is controversial.

The use of utilization data in relation to the recent Alberta health reforms was a concern to validity. Utilization data prior to the 1993/94 fiscal year needed to be used as health reforms, which began in this fiscal year, may have had a significant impact on the variation in utilization rates across geographic areas. Health Regions were created and were assigned significantly reduced budgets. Hospitals were closed in some areas and reorganized in others, transfers of service occurred among hospitals within the larger municipalities, and the nursing staff component of care was significantly reduced. Thus the impacts of the reforms were not uniform. For the purposes of this thesis, data for 1993 and beyond were not used. It was also appropriate to use data from years that were aligned closely with the 1991 census data from which population counts and SES variables were taken.

3.3.2 Selection of Small Areas

Geographic areas should not be too large in population size to avoid diluting the variation of SES. Alternatively, the areas should not be too small, as unstable estimates might occur if utilization rates were based on small numbers of utilization episodes, and were then used in a statistical model to determine relationships. Keeping this in mind, however, the total number of geographic areas needed to be high enough in order that the number of data points (geographic areas) would be large enough to use stepwise multiple regression analysis.

At the Alberta health region level, some regions were contained within geographic areas that were too small in terms of population size. The total number of health regions is only 17. Each of the two metropolitan centres, Edmonton and Calgary, are not broken into smaller areas, which would dilute variation in SES within the metropolitan health regions.

For these reasons, Federal Electoral District (FED) was selected as the geographic unit. FEDs provided 26 geographic areas (26 data points) for Alberta, and the population base in each was approximately 100,000 in 1991. A ratio of the maximum to minimum (max/min) population size for the 17 Alberta Health Regions was 50.32 while the same ratio for the FEDs was 1.86. Appendix B provides a map and list of FEDs; Appendix C provides a map and list of health regions or Regional Health Authorities (RHAs).

3.3.3 Hospital Utilization Data

The assumption was made that a measure of need based in utilization was necessary. Acute care utilization data was used as it likely reflects less professional uncertainty and possible unnecessary service than other health services. As well, acute care categories (ADRGs) offered the capacity to select cases that are of lowest risk to professional uncertainty to hospitalize. Through associated case weights (RDRGWs), estimates of resource use were possible. Finally, hospital abstract data were available for this study whereas data from other areas of health service were not.

While using the entire data set of acute care utilization cases would provide a more accurate analysis and predictive model for acute care utilization itself, it would not provide an appropriate measure of need, as discussed in Chapter II.

3.4 Steps in Methodology

The study required five basic sequential steps which are described below.

3.4.1 Step One: Population Tabulations

For each census enumeration area (EA) in Alberta, population counts by gender and five-year age groups were accessed from the 1991 Canada Census files. These EA specific population counts were aggregated to form the Federal Electoral District (FED) level counts and the Regional Health Authority level counts. For hospital separation abstract files, and death files, a look-up file was used to convert postal codes to EA codes and then aggregated to form FED level and Regional Health Authority (RHA) level files.

3.4.2 Step Two: Standardized Mortality Ratio

All-cause SMR (< 75 years) per small area was used. Postal codes in death files were converted to EA and then to FED code. Three years of death data (1990 to 1992) were used. These data were used to calculate standardized mortality ratio (SMR), using the 1991 Alberta age-sex mix as the standard.

The direct method of standardization (Henekens, p.71) was used. The age-sex category specific death ratios for each FED were applied to the number of age-sex specific Alberta population counts to arrive at the "expected" deaths per person years if the same death ratios occurred in the standard population. The sum of the expected deaths was then divided by the total Alberta population to arrive at a standardized mortality ratio for the geographic area being examined.

3.4.3 Step Three: Hospital Utilization Rates

The measures of utilization were population-based per capita measures for acute care hospital cases. They included number of separations, patient-days, and resource weights (RDRGWs), per 1,000 age-sex standardized person-years. These rates were termed Standardized Utilization Rates (SURs). Only the RDRGW rate was considered valid and accurate enough to act as a proxy measure of resource utilization and health need.

Selection of professionally certain ADRG categories, based on ADRG descriptors (Appendix D), was carried out by a medical doctor and professor in the Public Health Sciences Department, University of Alberta, with extensive experience in the acute care field. The medical doctor determined which ADRG categories of illnesses and procedures are likely subject to minimum professional uncertainty in decision making with respect to whether or not the patient must be admitted to an acute care hospital.

RDRGWs were calculated by selecting the RDRG code for each case found on the hospital separation abstract files, and then applying the RDRG case and day weights developed by Jacobs, Bay & Hall (1993). For each case, the "Option B" case weights were applied. For length of stay (LOS) outliers, 40% (for RDRG levels

0, 1) or 70% (for levels 2, 3) of day weights were added to the separation weights. The LOS outlier cut-off points are determined by the 75th percentile plus 2 times the inter-quartile range of ALOS for each RDRG (Jacobs, Bay & Hall, 1993).

3.4.4 Step Four: Socioeconomic Status Variables

The extraction of SES variables from the Alberta portion of the 1991 census (2B Profile) began with a careful assessment of relevant variables. The first consideration was that the longstanding constructs of income, education and occupational status be incorporated. As noted above, an accurate measure of occupational status was not possible given the available data.

The second consideration was that the measures be well-accepted based on previous studies. Some researchers (Benzeval, et. al., 1995; Nickens, W., 1995), recommend that race not be used as a variable in health care utilization studies. These researchers note that underlying socioeconomic status variables, such as income and education, have been shown to be more significant than race itself. However, due to the vast differences in health status that exist between aboriginal and non-aboriginal people in Canada, percent of the population that is aboriginal was tested for inclusion in the models. It was assumed that aboriginal status is likely not a direct causal variable, but an indirect measure of SES and a measure of general vulnerability.

Mean value of dwelling has been used in previous studies. However, it was considered likely to also reflect the real estate market across the province rather than act as a valid measure of wealth or housing condition. This measure may be more useful within a large health region. The variable which measures the proportion of households paying less than 30 percent of household income on rent or housing payments was not used as it was considered to be a measure that is theoretically too similar to that of low income families - a measure included in this study. Percent of low income families measures the number of economic families at the poverty lines.

Single parent status was used primarily due to its use in British studies of deprivation. However, it was also recognized, in early analysis, that this variable tends to display very high inter-correlations (.90 and higher) with other SES elements of major importance such as income and unemployment. For this reason, the variable was later dropped for analysis purposes.

Based on the literature, the selected SES variables (and related definitions) from the 1991 census are the following (Statistics Canada, 1992, A):

(1) **Unemployment rate**: a ratio of the unemployed population over the labour force population. The unemployment rate is normally reported as a percent (i.e., rate X 100).

(2) **Total income per capita**: a ratio of total declared income from all individuals for all income sources in 1990 over the total population.

(3) **Average income**: total income divided by the number of persons declaring income in 1990.

(4) **Percent of economic families living below Low Income Cut-Offs**: the percent of all "economic" families, defined as individuals living together who are related by blood or marriage (including common law relationships) or adoption. Low Income Cut-Offs (LICOs) are set where before-tax income is at a level that represents what the average household, with adjustment for family size and level of urbanization, spends on the basic needs of food, clothing and shelter, plus 20% (Cook W. and Mount J., 1986).

(5) **Percent of persons living below LICOs**: percent of family units (singles are one-person family units) with incomes below the Low Income Cut-Offs.

(6) **Percent of census families headed by a single parent**: lone parent census families divided by all census families X 100. Census families include all husband-wife families (including common-law relationships) with or without children, lone-parents of any marital status with one or more children, living in the same dwelling.

(7) **Percent of the 15 year and older population with less than grade nine education.**

(8) **Percent of the 15 year and older population without grade twelve education** (which includes the small population between 15 and 18 years who are in school and not yet capable of reaching this level of education).

(9) **Percent of persons in the population indicating a single ethnic status of aboriginal**: persons with a single ethnic status include those who provided only one response to the census question of ethnic identity. The measure

was calculated as single ethnic status aboriginals divided by the total population per geographic area X 100.

3.4.5 List of Variables and Variable Names

As noted earlier, hospital-day rates and admission (or separation) rates were generated, and basic analysis was provided, but these variables were not used as selected measures of importance for the study. The list of variables and variable names used in the study are:

Standardized Mortality Ratio All Ages	= SMR
Standardized Mortality Ratio < 75 Years	= SMR75
Standardized Utilization Rate (All RDRGWs)	= SUR
Standardized Need Rate (Certain RDGRWs)	= SNR
Total Income Per Capita	= $TICAP
Average Income	= $AVGINC
Percent Families Low Income	= %FAMLOW
Percent Persons Low Income	= %PERSLOW
Unemployment Rate	= %UNRATE
Percent Less than Grade 9 Educ.	= %GRADE9
Percent Less than Grade 12 Educ.	= %GRADE12
Percent Families Single Parent	= %SPARENT
Percent Population Aboriginal	= %ABORIG

3.4.6 Step Five: Modelling and SES Relative Value Scale

Stepwise multiple regression analysis was used with the set of SES and SMR variables to select and obtain a linear combination of those variables providing the strongest association with the standardized utilization rate (SUR) and standardized need rate (SNR). The regression coefficients, generated from the small area analysis, were then applied to the independent variables at the health region level to generate expected SUR and SNR rates for health regions. The expected value for each health region was then divided by the lowest expected value for health regions to provide a relative value scale.

3.5 Limitations

The primary limitation in this thesis is that the approach taken did not allow for any control over the data. All data sources were secondary and therefore had to be used with their inherent limitations.

Specific limitations are:

(1) Postal codes were used for geo-coding to the selected areas. This results in some errors both in the accuracy of the data collected and also the attribution of data to selected geographic areas. Some data are lost in the matching processes.

(2) This study made the assumption, based on the findings in the literature, that variation across geographic areas, and professional uncertainty in the decision to hospitalize, is lowest for the more intense and complex acute care cases; and, acute care cases, by their nature, reflect less uncertainty than cases in other areas of health services. Therefore in selecting acute care cases of high certainty, this study assumed that need for service beyond certain hospital service (i.e., uncertain hospitalization, outpatient care, long term care and home care) is similar to certain hospital service. More study,

including an analysis based on other health care services, may be needed to validate this assumption.

(3) Acute care utilization data, as used in this study, provides only estimates of resource use and resource need. RDRGWs have inherent weaknesses as identified earlier in the study, including the fact they are not based exclusively on Alberta or Canadian data.

(4) Although a physician and professor, with significant expertise and experience in acute care, selected professionally certain cases from the list of ADRG categories (Appendix D), subjectivity cannot be avoided and may have introduced some personal bias.

(5) A final limitation was imposed by not being able to access the complete Statistics Canada census database on occupations to determine an accurate measure of low occupation status per geographic area. If such access were possible, then measures of all three traditional SES variables - income, education, and occupation - could have been tested. The cost to purchase the additional data was prohibitive. As education is highly correlated with occupation, this limitation is not likely to significantly influence the outcomes of the thesis.

CHAPTER IV

FINDINGS AND INTERPRETATIONS

This chapter provides descriptive statistics at the small area level (FED) and Alberta Health Region level. It then provides regional correlates for the measures used, describes the results of regression analyses and provides interpretation. The chapter then provides a description of the SES Relative Value Scale development, its application, and interpretation.

4.1 Descriptive Findings

Descriptive findings for population size, SES variables, SMR, the SUR and SNR measures are provided below. Comparison between the geographic areas is provided.

4.1.1 Population

Tables 1a and 1b display population size for the small areas or FEDs, and the Regional Health Authorities or RHAs. The FEDs had an average population (1991) of 97,738 and the health regions 149,481. FEDs ranged in population size from a minimum of 72,535 for FED02 (Beaver River) to a maximum of 128,590 for FED04 (Calgary North). A max/min ratio of 1.86 was found. By comparison, health regions ranged in population size from a minimum of 14,980 in RHA17 (Northwestern) to a maximum of 753,814 for RHA04 (Calgary): Max/min = 50.32.

Table 1a

Population and Major Socioeconomic Variables in the Study from the 1991 Census For Federal Electoral Districts in Alberta								
Federal Electoral District Name	FED #	1991 Population Size	%GRADE12	%GRADE9	%ABORIG	%UNRATE	$TICAP	%PERSLOW
Athabasca	01	79,520	28.96	13.36	13.66	9.12	$15,453	14.87
Beaver River	02	72,535	30.69	14.13	8.80	8.19	$12,517	14.74
Calgary Centre	03	103,625	18.88	7.15	1.17	9.23	$19,587	28.56
Calgary North	04	128,590	20.23	5.55	0.51	7.49	$19,950	14.72
Calgary Northeast	05	124,270	29.08	8.97	1.15	9.23	$14,256	19.86
Calgary Southeast	06	119,670	28.09	6.70	0.97	8.35	$18,088	17.19
Calgary Southwest	07	125,150	19.37	2.93	0.32	6.83	$22,610	11.42
Calgary West	08	108,160	21.49	5.41	0.98	7.65	$20,416	17.29
Crowfoot	09	69,275	34.78	11.65	0.60	4.93	$11,687	13.74
Edmonton East	10	94,755	30.73	15.27	5.27	12.76	$12,859	33.54
Edmonton North	11	116,555	29.27	9.79	1.77	9.22	$15,190	20.34
Edmonton Northwest	12	81,050	26.50	10.54	3.20	10.92	$17,012	31.93
Edmonton Southeast	13	112,895	24.26	7.07	0.97	8.25	$16,042	16.66
Edmonton Southwest	14	117,720	21.30	4.83	1.52	7.64	$21,146	16.50
Edmonton-Strathcona	15	93,255	18.21	6.21	0.77	7.58	$19,194	22.93
Elk Island	16	86,680	26.17	4.81	0.44	5.28	$17,883	6.64
Lethbridge	17	99,980	27.54	9.85	5.92	8.53	$13,892	15.69
Macleod	18	73,040	30.70	9.01	6.91	6.93	$15,053	11.43
Medicine Hat	19	90,980	31.98	13.25	0.84	6.30	$13,859	14.72
Peace River	20	106,800	33.13	14.93	7.30	7.85	$12,766	14.49
Red Deer	21	103,245	32.03	8.12	1.56	7.77	$15,074	15.40
St. Albert	22	95,475	26.17	5.13	2.26	6.11	$17,055	7.41
Vegreville	23	72,980	34.24	14.39	0.67	4.83	$13,473	13.11
Wetaskiwin	24	84,240	33.86	11.26	2.52	6.15	$13,370	13.82
Wild Rose	25	91,685	29.22	7.46	2.62	5.56	$15,754	10.42
Yellowhead	26	89,045	34.19	10.84	3.23	7.52	$14,208	11.43
Alberta Rates		2,541,175	27.08	8.79	3.57	7.77	$16,092	16.65
Minimum		69,275	18.88	2.93	0.32	4.83	$11,687	6.64
Maximum		128,590	34.78	15.27	13.66	12.76	$22,610	33.54
Max./Min.		1.86	1.84	5.21	42.68	2.64	1.93	5.05

Table 1b

Population and Major Socioeconomic Variables in the Study from the 1991 Census For Alberta Health Regions									
Health Region Name	HR#	1991 Population Size	%GRADE12	%GRADE9	%ABORIG	%UNRATE	$TICAP	%PERSLOW
Chinook	01	136,496	29.11	10.63	5.73	8.06	$13,068	14.40
Palliser	02	81,583	31.61	13.14	3.11	6.92	$13,111	14.86
Headwater	03	58,275	28.15	7.44	4.60	5.83	$14,541	10.88
Calgary	04	753,814	22.97	5.92	0.89	7.97	$19,020	16.12
Health Region 5	05	43,049	33.52	10.07	0.54	4.77	$11,429	13.70
David Thompson	06	157,066	32.84	9.02	1.27	7.10	$14,124	15.09
East Central	07	98,078	34.91	12.26	0.84	4.88	$12,426	11.91
Westview	08	78,917	30.77	7.76	2.46	7.47	$14,448	9.42
Crossroads	09	69,693	32.98	11.03	3.09	6.17	$13,896	11.45
Capital	10	657,283	24.77	8.32	2.02	8.91	$17,128	20.78
Aspen	11	80,885	34.26	12.36	3.43	6.63	$12,314	11.61
Lakeland	12	157,184	28.40	10.44	4.05	6.44	$14,539	9.79
Mistahia	13	77,185	34.00	11.08	4.53	7.61	$13,142	13.64
Peace	14	20,587	30.89	16.38	5.36	7.14	$12,058	11.34
Keeweetinok Lake	15	18,610	30.24	20.36	30.66	13.34	$8,622	18.82
Northern Lights	16	37,489	24.02	6.05	8.80	8.98	$21,160	10.12
Northwestern	17	14,980	28.93	35.59	30.26	12.28	$8,751	14.85
Alberta Rates		2,541,175	27.08	8.79	3.57	7.77	$16,092	16.65
Minimum		14,980	22.97	5.92	0.84	4.88	$8,622	9.42
Maximum		753,814	34.91	35.59	30.66	13.34	$21,160	20.78
Max./Min.		50.32	1.52	6.01	36.50	2.73	2.45	2.21

4.1.2 Socioeconomic Status

Tables 1a and 1b also display the major SES variables. A high degree of variation in SES was found across the 26 FEDs. The percentage of persons at the poverty lines (%PERSLOW) ranged from 33.54% in FED10 (Edmonton East) to 6.64 in FED16 (Elk Island). FED22 (St. Albert), which includes the municipalities of St. Albert and Spruce Grove, also had a low %PERSLOW value (7.41%). The percent of the 15 year and older population with less than a grade nine education (%GRADE9) ranged from a high of 15.27% in FED10 (Edmonton East) to a low of 2.93% in FED09 (Calgary Southwest).

FED01 (Athabasca) and FED20 (Peace River), in northern Alberta, show relatively high values for percent of population with poor education, and percent of population that is aboriginal. At the Regional Health Authority level, where these two FEDs are broken down into approximately 4 health regions, RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) show values for these same variables that are much higher, reaching levels of 35% for less than grade nine education and 30% for population that is aboriginal (Tables 1a and 1b).

While the FED geographic level provides stable population size, and stable ratios and percentages, the names of the FEDs can be misleading in interpreting the descriptive findings. FED10 (Edmonton East) for example displays values that reflect very poor SES, but its geographic boundaries should not be confused with the east side of Edmonton generally. The FED of Edmonton East is actually contained on the north side of the North Saskatchewan river and includes much of the downtown area, and most of what is considered the "inner-city" area.

Therefore, interpretation of the descriptive findings for the various geographic areas requires an awareness of the population size and particular geographic boundaries. Appendix B and Appendix C provide FED and RHA maps for a basic understanding of the geographic boundaries.

4.1.3 Standardized Mortality Ratio

Total deaths in Alberta for years 1990, 1991 and 1992 were 43,514 for an average of 14,505 per year. Fifty-six percent of the persons were male and 44% female. Table 2 displays deaths as standardized mortality ratio per 1,000 person-years for all age groups and for the less than 75 year age groups.

FED10 (Edmonton East) shows the highest value for the SMR75 variable, 3.02 premature deaths per 1,000 person-years. FED21 (Red Deer) and FED04 (Calgary North) display the lowest values, 1.27 and 1.46 respectively.

4.1.4 Standardized Utilization Rate (SUR), and Need Rate (SNR)

Table 2 also displays measures of age-sex standardized rates of utilization and need. The measures are acute care resource rates in the form of RDRG weights (RDRGWs) per 1,000 person-years.

Table 2

Age-Sex Standardized Rates for All RDRGWs, Certain RDRGWs, and All-Cause SMR Per 1,000 Person-Years for Federal Electoral Districts in Alberta

Federal Electoral District Name	FED #	Population Size (000)	SUR Actual RDRGW Rate	SNR Certain RDRGW Rate	All-Cause SMR All Ages	All-Cause SMR Age <75
Athabasca	01	79.520	251.61	69.85	4.38	2.35
Beaver River	02	72.535	222.49	63.80	4.35	2.29
Calgary Centre	03	103.625	146.20	57.49	3.68	2.15
Calgary North	04	128.590	116.59	52.34	3.16	1.46
Calgary Northeast	05	124.270	132.14	55.07	3.80	1.92
Calgary Southeast	06	119.670	145.48	61.36	4.12	2.07
Calgary Southwest	07	125.150	125.15	53.09	3.39	1.62
Calgary West	08	108.160	130.55	56.10	3.40	1.72
Crowfoot	09	69.275	204.50	62.65	4.17	1.97
Edmonton East	10	94.755	152.82	66.41	5.07	3.02
Edmonton North	11	116.555	123.15	55.07	4.74	2.41
Edmonton Northwest	12	81.050	137.14	57.61	4.67	2.69
Edmonton Southeast	13	112.895	119.62	56.27	3.83	1.90
Edmonton Southwest	14	117.720	111.79	51.93	4.60	2.18
Edmonton-Strathcona	15	93.255	115.11	52.45	3.48	1.91
Elk Island	16	86.680	127.86	53.70	4.10	2.01
Lethbridge	17	99.980	191.45	64.39	4.75	2.47
Macleod	18	73.040	176.39	56.05	4.78	2.35
Medicine Hat	19	90.980	189.95	62.23	4.00	2.06
Peace River	20	106.800	241.31	67.17	3.13	1.66
Red Deer	21	103.245	164.68	61.29	2.39	1.27
St. Albert	22	95.475	122.21	53.85	4.70	2.23
Vegreville	23	72.980	200.47	55.54	4.20	2.02
Wetaskiwin	24	84.240	213.38	68.06	3.76	2.07
Wild Rose	25	91.685	163.03	58.23	4.24	2.06
Yellowhead	26	89.045	185.47	59.29	5.59	2.87
Alberta Rates		2541.175	157.53	58.53	4.05	2.08
Minimum		69.275	109.56	51.93	2.39	1.27
Maximum		128.590	245.32	69.85	5.59	3.02
Max./Min.		1.86	2.24	1.35	2.34	2.38

Standardized utilization rate (SUR) displayed significant variation between northern and southern areas of the province, and between central metropolitan and less urbanized areas. For example, values ranged from near 100 RDRGWs per 1,000 person-years in FED14 (Edmonton Southwest), FED15 (Edmonton-Strathcona) and FED03 (Calgary North) to values over twice as high for FED01 (Athabasca), FED20 (Peace River) and FED02 (Beaver River).

As expected, variability across geographic areas for the need rate (SNR), or professionally certain resource weight rate, reduced considerably from the total utilization rate (SUR). The max/min ratio reduced from 2.25 to 1.35. The number of cases selected as certain, by the process used in this study, resulted in 38% of all possible standardized resource weights being included. The resulting resource-based need rate (SNR) was relatively high in FED01 (Athabasca), FED24 (Wetaskiwin) and FED20 (Peace River), and, relatively low in FED14 (Edmonton Southwest), FED15 (Edmonton-Strathcona), FED04 (Calgary North) and FED07 (Calgary Southwest).

Basic statistics for all variables are displayed in Table 3. The coefficient of variation (CV) indicates that the relative dispersion between the SES variables was considerable, ranging from 18.5 percent of the average for total income per capita to 110 percent for percent population aboriginal. The CV was below 100 percent for almost all SES variables, providing one justification for treating the units of the SES variables as continuous and using the Pearson correlation procedure, (in addition to an ordinal procedure), to explore bivariate relationships with the

Table 3

Basic Statistics For All Variables in the Study (Unit = FED)							
Variables	Basic Statistics						
	Mean	Std. Dev.	Range	Minimum	Maximum	Max/Min	C.V.
Standardized Mortality Ratio							
SMRs for all Age Groups (Per 1,000)	4.10	0.70	3.20	2.39	5.59	2.34	17.05%
SMRs for 0 - 75 yrs. Population (Per 1,000)	2.11	0.40	1.75	1.27	3.02	2.38	19.05%
Socioeconomic Variables							
Total Income Per Capita (K$)	16.09	2.97	10.92	11.69	22.61	1.93	18.46%
Average Income (K$)	23.79	23.79	11.20	19.70	30.90	1.57	100.00%
Low Income Families (%)	13.88	5.45	23.59	5.78	29.38	5.08	39.22%
Low Income Persons (%)	16.49	6.58	26.90	6.64	33.54	5.05	39.90%
Unemployment Rate (%)	7.70	1.80	7.93	4.83	12.76	2.64	23.43%
15 yrs.+ Population < Gr. 9 Educ. (%)	9.18	3.58	12.35	2.93	15.27	5.22	39.01%
15 yrs.+ Population < Gr. 12 Educ. (%)	27.73	5.16	16.57	18.21	34.78	1.91	18.60%
Aboriginal (%)	2.92	3.23	13.34	0.32	13.66	43.27	110.65%
Single Parent Families (%)	12.26	3.43	13.97	7.74	21.71	2.80	27.95%
Standardized Utilization Rates							
All Acute Care Days / 1,000 Person-Yrs.	1063.50	272.36	909.38	723.98	1633.36	2.26	25.61%
All Acute Care Seps. / 1,000 Person-Yrs.	156.90	52.49	167.18	99.49	266.67	2.68	33.45%
All Acute Care RDRGWs / 1,000 Person-Yrs.	161.94	41.77	139.83	111.79	251.61	2.25	25.79%
Standardized Need Rates							
Certain Acute Care Days / 1,000 Person-Yrs.	359.56	38.44	122.81	301.59	424.40	1.41	10.69%
Certain Acute Care Seps. / 1,000 Person-Yrs.	49.25	5.13	17.71	41.78	59.49	1.42	10.41%
Certain Acute Care RDRGWs/1,000 Person-Yrs.	58.90	5.32	17.92	51.93	69.85	1.34	9.03%

dependent measures. Generally, a CV of less than 100 percent suggests the data tend to approximate a normal distribution and can be more likely treated as continuous and able to display linear relationships.

The max/min ratio for the measures of acute care patient-days, separations, and resource weights (RDRGWs) in Table 3 was over 2.25, but reduced to less than 1.45 when an effort was made to remove uncertainty from the data. Max/min ratios varied substantially between the SES variables, ranging from 1.57 for average income to 43.27 for the aboriginal component of the population.

Given the above finding, the selection procedure undertaken to control for uncertainty had a significant impact from a statistical perspective. SES measures were likely to provide a capacity for association with the dependent measures given the wide variation they displayed.

4.2 Regional Correlates

Bivariate analysis was conducted to investigate the association of SMR with acute care utilization, SMR with SES, and, SES with acute care utilization. Due to the methodology used (small area analysis), which provides only a limited number of data points, and due to possible questions about level of measurement for some of the SES variables (percentage units with a limited range of values), both the Pearson correlation procedure for continuous level variables and the Spearman rank order correlation procedure for ordinal level variables were applied. Tables 4 and 5 display the findings in the form of correlation matrices for all variables in the study,

Table 4

Pearson Correlation Matrix for all Variables in the Study (Unit = FED, N = 26)

Variables	Total Income/ Capita	Avg. Income	% Low Inc. Families	% Persons Low Inc.	% Unemp. Rate	% < Gr. 9 Educ.	% < Gr. 12 Educ.	% Pop. Aborig.	% Families S.Parent	All Days / 1000	All Seps./ 1000	All RDRGW /1000	SMRs / 1000	0-75 yr. SMRs / 1000	Certain Days / 1000	Certain Seps. / 1000
Average Income	.9009*															
% Low Income Familes	-.0492	-.3180														
% Persons Low Income	.0216	-.3362	.9819*													
Unemployment Rate (%)	-.0028	-.2284	.8766*	.8288*												
% < Gr. 9 Educ.	-.8505*	-.8046*	.2931	.2297	.2259											
% < Gr. 12 Educ.	-.9365*	-.8030*	.0490	-.0409	-.0062	.9116*										
% Population Aboriginal	-.4037*	-.2064	.0585	.0097	.3347	.5579*	.4384*									
% Families Single Parent	.1528	-.1602	.9275*	.8956*	.9208*	.0516	-.1674	.0245								
All Days / 1000	-.7146*	-.5203*	-.1151	-.1404	-.1058	.8092*	.7969*	.6633*	-.3349							
All Separations / 1000	-.6891*	-.4443*	-.2416	-.2676	-.1956	.7661*	.7752*	.6729*	-.4376*	.9822*						
All RDRG Ws / 1000 (SUR)	-.7073*	-.4818*	-.1810	-.2083	-.1391	.7876*	.7888*	.6845*	-.3852	.9937*	.9949*					
SMRs / 1000 (All Ages)	-.2837	-.2206	.1299	.0710	.2006	.2730	.2973	.2967	.0656	.0733	.0620	.0808				
SMRs / 1000 (<75 Yrs.)	-.3259	-.3659	.4153*	.3691	.4638*	.4104*	.3424	.3889*	.3103	.1526	.0941	.1375	.9259*			
Certain Days / 1000	-.6180*	-.5782*	.2675	.2397	.2790	.7458*	.6701*	.5596*	.1052	.8201*	.7351*	.7878*	.0238	.2226		
Certain Seps. / 1000	-.6612*	-.4736*	-.0590	-.1043	.0378	.7197*	.7274*	.6596*	-.1926	.9154*	.8914*	.9159*	.0098	.1296	.8877*	
Certain RDRGWs / 1000 (SNR)	-.6679*	-.5557*	.1616	.1103	.2356	.7427*	.7114*	.6530*	.0265	.8479*	.7820*	.8309*	.0769	.2546	.9562*	.9529*

* Statistical Significance at .05

Table 5

Spearman Rank Order Correlation Matrix for all Variables in the Study (Unit = FED, N = 26)

Variables	Total Income/ Capita	Avg. Income	% Low Inc. Families	% Persons Low Inc.	% Unemp. Rate	% < Gr. 9 Educ.	% < Gr. 12 Educ.	% Pop. Aborig.	% Families S.Parent	All Days / 1000	All Seps./ 1000	All RDRGW /1000	SMRs / 1000	0-75 yr. SMRs / 1000	Certain Days / 1000	Certain Seps. / 1000
Average Income	.8899*															
% Low Income Familes	.0715	-.2000														
% Persons Low Income	-.0024	-.1863	.9815*													
Unemployment Rate (%)	.0571	-.1480	.8612*	.8366*												
% < Gr. 9 Educ.	-.9296*	-.8209*	.1706	.1138	.1925											
% < Gr. 12 Educ.	-.4414*	-.7874*	-.0571	-.1268	-.0550	.9132*										
% Population Aboriginal	-.4421*	-.3299	.1631	.1091	.4373*	.5460*	.4236*									
% Families Single Parent	.2916	.0099	.9255*	.9221*	.8858*	-.0742	-.2903	.1296								
All Days / 1000	-.7901*	-.6109*	-.1720	-.2212	-.0516	.8202*	.8174*	.5275*	-.4010*							
All Separations / 1000	-.7545*	-.5590*	-.2130	-.2629	-.0831	.7997*	.8038*	.5221*	-.4297*	.9911*						
All RDRG Ws / 1000 (SUR)	-.7812*	-.6007*	-.1850	-.2335	-.0612	.8106*	.8079*	.5179*	-.4099*	.9993*	.9932*					
SMRs / 1000 (All Ages)	-.2745	-.2629	-.0215	-.0243	.1364	.2985	.2814	.5091*	-.0250	.1412	.1467	.1289				
SMRs / 1000 (<75 Yrs.)	-.2554	-.3026	.1959	.1836	.3559	.3826	.2650	.6301*	.1569	.2376	.2315	.2246	.9111*			
Certain Days / 1000	-.6520*	-.6232*	.1918	.1597	.2759	.7826*	.6855*	.4940*	.0099	.8448*	.8174*	.8434*	.0851	.2752		
Certain Seps. / 1000	-.7142*	-.5542*	-.1234	-.1651	.0133	.7361*	.7388*	.5597*	-.2978	.9357*	.9323*	.9385*	.0988	.2062	.8961*	
Certain RDRGWs / 1000 (SNR)	-.7012*	-.6315*	.1227	.0776	.2410	.7600*	.7039*	.5952*	-.0557	.8516*	.8243*	.8496*	.1391	.3053	.9446*	.9439*

* Statistical Significance at .05

including the additional dependent measures of acute care hospital utilization in the form of standardized hospital patient-days and separations. Bivariate correlations were similar for both correlation procedures. For example, the Pearson correlation for Total Income per Capita with SNR was -.67 and for the Spearman correlation it was -.70. For Less than Grade Nine Education the correlations with SNR were .74 and .76 respectively. This finding helped validate the statistical relationships found, the small area selection that was made, and also supported the intention to treat the variables as continuous and linear.

4.2.1 Acute Care Utilization and SMR

SMR for all age groups, and the less than 75 year age groups, displayed no statistically significant correlations with measures of acute care utilization at the .05 level. However the strength of the correlations did increase for the measures of professionally certain utilization. The resource weight measure of SNR had the strongest correlation, .25 (Pearson) and .31 (Spearman).

4.2.2 SMR and SES

Associations between SMR (for all age groups) and SES variables were not statistically significant. SMR75 displayed weak statistically significant correlations, at the .05 level, with measures of low income, low education, unemployment rate and aboriginal population. The highest correlations were .46 (Pearson) with unemployment rate and .63 (Spearman) with percent aboriginal population.

4.2.3 Acute Care Utilization Measures and SES

Measures of low education, aboriginal component, and income per capita correlated strongly with standardized utilization rate (SUR) and standardized need rate (SNR). The Pearson correlations between SUR are .78, .68, and -.71 respectively for low education, aboriginal and income per capita. Corresponding values for SNR are .74, .65, and -.67 respectively.

A most interesting finding was the shift in the direction of correlations between SES measures and SUR, and, SES measures and SNR. Unemployment rate, low income persons, low income families, and single parent families correlated negatively with SUR but positively with SNR. This finding may indicate that areas with populations having higher components of low income, unemployment, and single parents, use less resources than other areas. For the rates of certain hospital patient-days, certain admissions and certain resource weights (SNR), the direction of the correlation became positive. Pearson correlations for unemployment rate and low income persons with SUR are -.06 and -.23 respectively, but are .24 and .08 respectively for SNR. The shift in direction may indicate that areas with higher levels of low income persons and unemployment, use less resources but need more.

By contrast, the variables of low education, aboriginal population, and total income per capita demonstrated strong and stable positive correlations, with directions that lend themselves to clear theoretical understanding. Geographic areas with significant levels of low education, high aboriginal population, and low income, both utilize and need more health resources, relative to other areas.

Pearson correlations with these three variables and SUR are .81, .52 and -.78 respectively. For SNR, the correlations are .76, .59 and -.70 respectively.

For the multivariate analysis that follows, the single parent variable was purposely removed due to its high level of inter-correlation with unemployment rate (.89) and the two measures of low income (.92 and .93). Low income persons was used as opposed to low income families as it is a more complete measure of low income and because of high inter-correlation between the two. However, both measures of low education were retained due to the question of which represents a valid measure in today's society. The literature indicates that a valid measure of low education varies depending upon broad age groups.

4.3.0 Regression Analyses

The primary purpose of regression analysis for this study was exploratory and not confirmatory. The analyses are not intended to test specific relationships but to find a linear function that could predict maximally the resource-based utilization and need patterns after age and gender effects are controlled for by the standardization procedure. While the relationships found are valid, especially since the data are from a population as opposed to a sample, they should not be seen as a definitive explanation of socioeconomic status and need for health.

Stepwise regression analysis was used to select variables and to produce a statistical linear function for two reasons. First, the theoretical and statistical understanding that SMR and SES variables can be used to measure health need and health service utilization is commonly accepted without clear empirical linkages. Secondly, the specific function of SES to use is obscure in general. There has been no research report, when the dependent measure is utilization-based, in particular.

Therefore stepwise regression was used, with levels of acceptance and removal of variables set to the maximum of .49 and .51 respectively to force the entry of all independent variables. The pareto effect was relied upon to find the combination of variables that provided the highest R-square value, with each variable contributing to the overall value.

4.3.1 SMR (<75 years) as Dependent

When the selected SES variables were regressed on SMR75, %UNRATE was the only variable selected by the procedure. An R-square value of .21 was attained.

4.3.2 Standardized Utilization Rate (SUR) as Dependent

The total utilization rate selected for regression analysis was the number of age-sex standardized resource weights (RDRGWs) per 1,000 person-years. When the selected SES measures in the study were regressed on SUR, the variables selected by the stepwise procedure were:

(1) %ABORIG,
(2) %GRADE9,
(3) %UNRATE.

The R-square value was .88. Thus the model accounted for 88% of the variation across the small geographic areas. The linear equation for the model was:

SUR = 156.43 + 6.33(%ABORIG) + 7.17(%GRADE9) - 10.23(%UNRATE)

A statistical interpretation of the model is that, after standardization for age and gender, for each percentage point increase in the aboriginal component of the population there was an increase of 6.33 resource weights of utilization per 1,000 person-years; for each percentage point increase in the less than grade nine education component there was a corresponding increase of 7.17 units of resource weight utilization per 1,000 person-years; for each percentage point increase in the unemployment rate there was a corresponding **decrease** of 10.23 units of resource weight utilization per 1,000 person-years. As noted in section 4.2.3 the unemployed tend to use less hospital service suggesting motivational factors in health service utilization behaviour.

4.3.3 Standardized Need Rate (SNR) as Dependent

The resource-based measure selected for regression analysis was the number of age-sex standardized resource weights, or RDRGWs, per 1,000 person-years, for cases with high certainty to hospitalize.

When SNR was used as a measure of need for health from a resource based perspective, three variables were selected by the stepwise procedure:

(1) %ABORIG,
(2) %PERSLOW,
(3) %GRADE12.

The model attained an R-square value of .66. Thus 66% of the variation in acute care resource weights, selected for certainty to hospitalize, was accounted for by the model. The linear equation for the model was:

SNR = 38.91 + .81(%ABORIG) + .18(%PERSLOW) + .53(%GRADE12)

A statistical interpretation of the model is that, after standardization for age and gender, for each percentage point increase in the aboriginal component of the population there was an increase of .81 units of professionally certain RDRGW resource weights per 1,000 person-years; for each percentage point increase in the percent of low income persons there was an increase of .17 units of professionally certain RDRGW resource weights per 1,000 person-years; for each percentage point increase in the less than grade twelve population there was an increase of .53 units of professionally certain RDRGW resource weights per 1,000 person-years.

4.3.4 Interpretation of Multiple Regression Findings

Using the selection procedure for this thesis, a more updated data set, or one that includes additional SES variables may result in a different selection and removal of variables, and changes to the coefficients. The statistical output from the stepwise procedures for the utilization model and the need model are found in Appendix E and Appendix F respectively.

While residual plots for both the SNR and SUR models indicated no visible patterns that would suggest greater specificity was possible or that transformations of the variables might improve the strength of the model, residual analysis is not recommended with a small number of data points. No transformations were made to the variables such as converting them to log linear units or exponential units. The intention was to provide a linear model as it provides stable output values. The assumption was made that the SES functions for acute care utilization and resource based need, as measured in this study, are linear.

SES measures were found to be much better at predicting utilization and need, as measured in this study, than was SMR75.

Variation of resource utilization among small geographic areas, after standardizing for age and gender, can be largely accounted for by three SES variables:

(1) percent of population with a single ethnic status of aboriginal,

(2) percent of 15 year and older population with less than grade 9 education,

(3) unemployment rate.

Variation in health resource-based need, among small geographic areas, can be largely accounted for by three SES variables:

(1) percent population with a single ethnic status of aboriginal,

(2) percent low income persons,

(3) percent 15 year and older population with less than grade 12 education.

It may be argued that the above variables do not fully account for a measure of the SES construct. The specific SES variables that were selected should be viewed only as indicators of SES and not as unique and additive components of SES. As Libertos (1988) has indicated, each variable making up the SES construct measures more than the variable itself. SES variables overlap. For example, over 50% of single parent families are also low income families (Oderkirk, 1992); persons with low education generally command lower salaries in the market place; the aboriginal population is known to have disproportionately high levels of low income, unemployment, and low education. Low education generally results in low occupational status.

4.4.0 Development of SES Relative Value Scales

The purpose of the models developed above is to produce relative values for standardized rates of utilization and need associated with SES, which can then be applied to age-sex adjusted populations.

4.4.1 SES Relative Value Scales at FED Level

Table 6 shows the actual SUR and SNR values that were estimated using RDRG categories for all records on the hospital abstract files and the case and day weights (RDRGWs) developed by Jacobs, Bay, and Hall (1993). The expected values are also shown. Expected values were generated by applying the regression models to the SES variables at the FED level. The expected values are statistically generated standardized RDRGWs per 1,000 person-years that associate with SES.

Instead of dividing each of the relative values by the Alberta rate, Relative Value Scale Utilization and Relative Value Scale Need were calculated by using the geographic area with the lowest value as the common base. The geographic area

Table 6

Expected Standardized Utilization Rate (SUR) and Need Rate (SNR) & Relative Value Scales for Socioeconomic Status Applied to Small Areas (Federal Electoral Districts)

Federal Electoral District Name	FED #	SUR Actual Utilization	SUR Expected Utilization	Relative Value Scale	SNR Certain Actual	SNR Certain Expected	Relative Value Scale
Athabasca	01	251.61	249.26	2.275	69.85	67.94	1.320
Beaver River	02	222.49	226.78	2.070	63.80	64.90	1.261
Calgary Centre	03	146.20	116.10	1.060	57.49	54.95	1.068
Calgary North	04	116.59	123.88	1.131	52.34	52.65	1.023
Calgary Northeast	05	132.14	136.30	1.244	55.07	58.78	1.142
Calgary Southeast	06	145.48	129.30	1.180	61.36	57.64	1.120
Calgary Southwest	**07**	**125.15**	**109.56**	**1.000**	**53.09**	**51.46**	**1.000**
Calgary West	08	130.55	124.61	1.137	56.10	54.16	1.053
Crowfoot	09	204.50	193.49	1.766	62.65	60.25	1.171
Edmonton East	10	152.82	165.81	1.513	66.41	65.42	1.271
Edmonton North	11	123.15	147.05	1.342	55.07	59.46	1.156
Edmonton Northwest	12	137.14	137.84	1.258	57.61	61.22	1.190
Edmonton Southeast	13	119.62	128.24	1.171	56.27	55.51	1.079
Edmonton Southwest	14	111.79	122.94	1.122	51.93	54.36	1.056
Edmonton-Strathcona	15	115.11	128.11	1.169	52.45	53.27	1.035
Elk Island	16	127.86	139.55	1.274	53.70	54.31	1.055
Lethbridge	17	191.45	179.63	1.640	64.39	61.07	1.187
Macleod	18	176.39	188.28	1.719	56.05	62.78	1.220
Medicine Hat	19	189.95	192.71	1.759	62.23	59.14	1.149
Peace River	20	241.31	231.89	2.117	67.17	64.94	1.262
Red Deer	21	164.68	145.12	1.325	61.29	59.88	1.164
St. Albert	22	122.21	144.22	1.316	53.85	55.91	1.087
Vegreville	23	200.47	214.55	1.958	55.54	59.92	1.164
Wetaskiwin	24	213.38	192.30	1.755	68.06	61.33	1.192
Wild Rose	25	163.03	167.75	1.531	58.23	58.36	1.134
Yellowhead	26	185.47	175.22	1.599	59.29	61.65	1.198
Alberta Rates		157.53	157.35	1.478	58.50	58.47	1.136
Minimum		111.79	109.56	1.00	51.93	51.46	1.00
Maximum		251.61	249.26	2.28	69.85	67.94	1.32
Max./Min.		2.25	2.28	2.28	1.35	1.32	1.32

with the lowest value was assigned a scale value of 1.000. FED07 (Calgary Southwest) had the lowest relative value for both utilization and need.

FED01 (Athabasca) has a standardized utilization rate (SUR), statistically explained by SES, that is 1.275 times or 127.5% greater than FED07. This finding indicates that, if total acute care utilization rate was used as the measure of need, the average person in FED 01 (Athabasca) has a need for health that is 127.5% greater than the average person in FED07 (Calgary Southwest). However, as described in Chapter II, measures of total utilization are not appropriate.

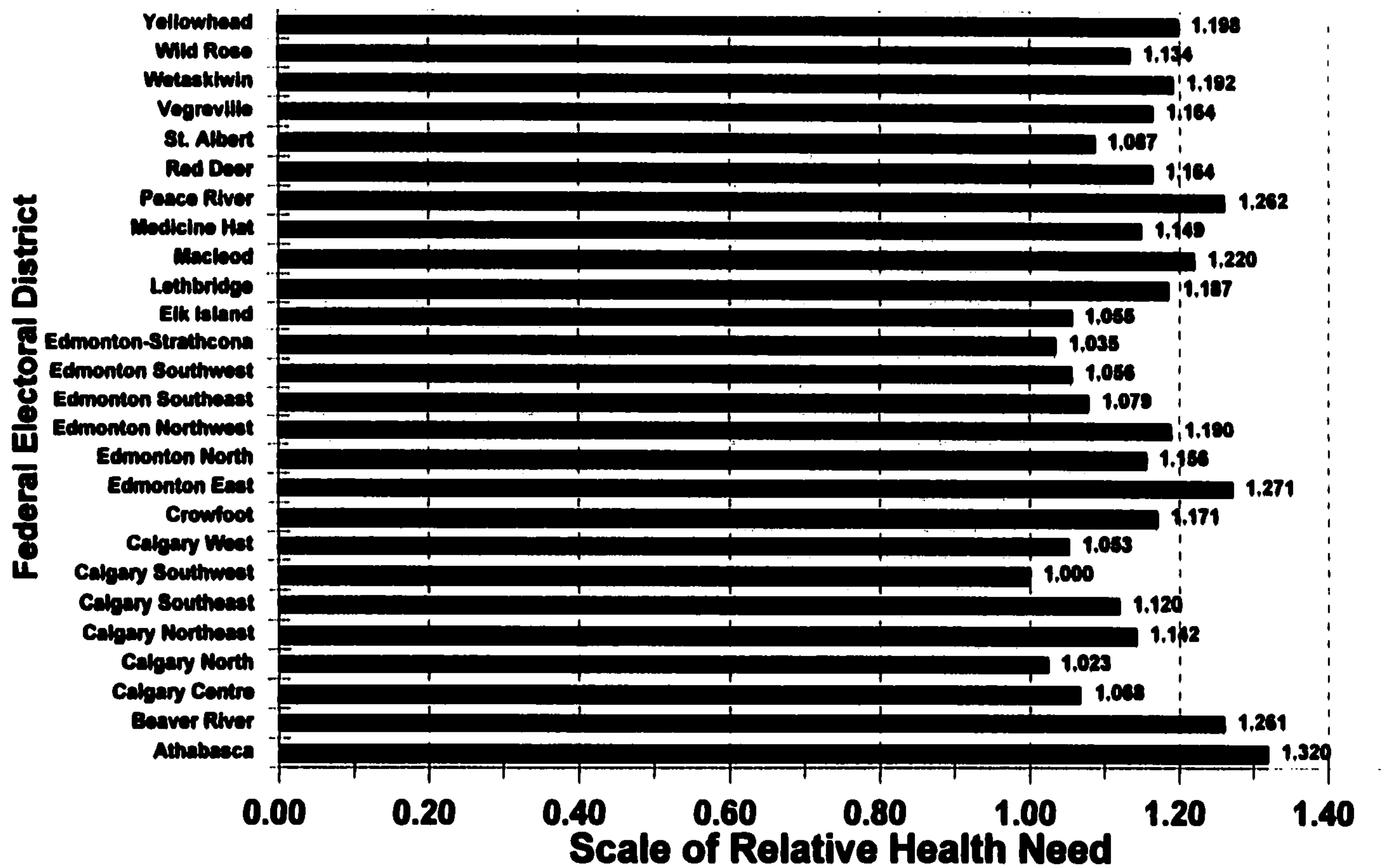
Using the SES need rate (SNR), the relative value for FED01 (Athabasca), or "Certain Expected" value, as displayed in Table 6, is 34% greater than FED07 (Calgary Southwest). This indicates that, based on a resource measure of need, the average person in FED01 has a need for health, explained by SES, that is 34% greater than the average person in FED07. Figure 1 shows the relative position of each of the FEDs. While the small area level analysis (FED) is of interest in analyzing relative need for health, the application of the model at the health region level (RHA) is required for fund allocation purposes.

4.4.2 Relative Value Scales Applied to Health Regions

Tables 7a and 7b show expected utilization and need values at the health region level, and SES Relative Value Scales Utilization and Need. RHA04 (Calgary)

Figure 1

Age-sex Adjusted Capita Health Need
Associated with Socioeconomic Status



Scale Value for Calgary Southwest = 1.00

Table 7a

Expected Standardized Utilization Rate (RDRGWs/1,000 Person-Years) and SES Relative Value Scale for Utilization Applied to Alberta Health Regions

Health Region Name	HR #	Population '94 Age-Sex Adjusted (000	SUR Expected Utilization	Relative Value Scale	%Budget Allocation Age-Sex Adjusted	%Budget Allocation RV Scale Applied	% Change Region Specific	% Change Overall Budget	Impact on a $ 2B Budget: $ Total Impact (000)	Impact on a $ 2B Budget: $ Per Capita Impact
Chinook	1	165.979	188.45	1.516	6.22%	7.39%	18.72%	1.16%	$23,291	$140
Palliser	2	92.797	199.49	1.622	3.48%	4.42%	27.02%	0.94%	$18,795	$203
Headwater	3	64.810	179.21	1.457	2.43%	2.77%	14.11%	0.34%	$6,856	$106
Calgary	4	748.061	123.01	1.000	28.04%	21.96%	-21.68%	-6.08%	($121,550)	($162)
Health Region 5	5	55.569	183.27	1.490	2.08%	2.43%	16.70%	0.35%	$6,955	$125
David Thompson	6	178.169	156.55	1.273	6.68%	6.66%	-0.32%	-0.02%	($422)	($2)
East Central	7	125.491	199.67	1.623	4.70%	5.98%	27.14%	1.28%	$25,526	$203
Westview	8	66.871	151.31	1.230	2.51%	2.41%	-3.66%	-0.09%	($1,833)	($27)
Crossroads	9	70.934	191.99	1.561	2.66%	3.25%	22.25%	0.59%	$11,830	$167
Capital	10	712.192	137.75	1.120	26.69%	23.41%	-12.29%	-3.28%	($65,597)	($92)
Aspen	11	80.243	198.95	1.617	3.01%	3.81%	26.68%	0.80%	$16,047	$200
Lakeland	12	162.931	191.00	1.553	6.11%	7.43%	21.62%	1.32%	$26,401	$162
Mistahia	13	71.624	186.68	1.518	2.68%	3.19%	18.87%	0.51%	$10,130	$141
Peace	14	19.445	234.75	1.908	0.73%	1.09%	49.47%	0.36%	$7,211	$371
Keewatinok Lake	15	18.627	359.97	2.926	0.70%	1.60%	129.20%	0.90%	$18,040	$968
Northern Lights	16	22.911	163.67	1.331	0.86%	0.89%	4.21%	0.04%	$724	$32
Northwestern	17	11.510	477.39	3.881	0.43%	1.31%	203.97%	0.88%	$17,598	$1,529
Alberta Rates/Sums		2,668.164	156.68	1.274	100.00%	100.00%	0.00%	18.90%	$378,805	$142
									$2B / 2668.164 =	$750

Table 7b

Expected Standardized Need Rate (RDRGWs/1,000 Person-Years) and SES Relative Value Scale for Need Applied to Alberta Health Regions										
Health Region Name	HR #	Population	SMR	Relative	%Budget Allocation		% Change	% Change	Impact on a $ 2B Budget	
		'94 Age-Sex Adjusted (000	Expected Need	Value Scale	Age-Sex Adjusted	RV Scale Applied	Region Specific	Overall Budget	$ Total Impact (000)	$ Per Capita Impact
Chinook	1	165.979	61.52	1.125	6.22%	6.57%	5.61%	0.36%	$6,982	$42
Palliser	2	92.797	60.80	1.112	3.48%	3.63%	4.38%	0.17%	$3,047	$33
Headwater	3	64.810	59.47	1.088	2.43%	2.48%	2.10%	0.07%	$1,019	$16
Calgary	4	748.061	54.66	1.000	28.04%	26.31%	-6.15%	-1.86%	($34,511)	($46)
Health Region 5	5	55.569	59.53	1.089	2.08%	2.13%	2.20%	0.10%	$918	$17
David Thompson	6	178.169	60.01	1.098	6.68%	6.88%	3.03%	0.20%	$4,045	$23
East Central	7	125.491	60.19	1.101	4.70%	4.86%	3.33%	0.24%	$3,136	$25
Westview	8	66.871	58.87	1.077	2.51%	2.53%	1.06%	-0.04%	$532	$8
Crossroads	9	70.934	60.91	1.114	2.66%	2.78%	4.56%	0.14%	$2,426	$34
Capital	10	712.192	57.37	1.049	26.69%	26.29%	-1.52%	-0.42%	($8,109)	($11)
Aspen	11	80.243	61.89	1.132	3.01%	3.20%	6.25%	0.18%	$3,758	$47
Lakeland	12	162.931	58.96	1.079	6.11%	6.18%	1.22%	0.07%	$1,491	$9
Mistahia	13	71.624	63.00	1.152	2.68%	2.90%	8.15%	0.22%	$4,378	$61
Peace	14	19.445	61.62	1.127	0.73%	0.77%	5.78%	0.03%	$842	$43
Keeweetinok Lake	15	18.627	83.07	1.520	0.70%	1.00%	42.61%	0.31%	$5,949	$319
Northern Lights	16	22.911	60.54	1.108	0.86%	0.89%	3.94%	0.03%	$676	$30
Northwestern	17	11.510	81.34	1.488	0.43%	0.60%	39.64%	0.18%	$3,420	$297
Alberta Rates/Sums		2,668.164	58.22	1.066	100.00%	100.00%	0.00%	4.63%	$85,246	$32

$2B / 2668.16 = $750

provided the lowest value for both SES RV Scales. The tables also show the percentage distribution of fund allocation based on an age-sex adjusted per capita basis, and age-sex adjusted per capita multiplied by the respective SES RV Scale. The impact of the SES RV Scale is provided by subtracting the percentage distribution for age-sex adjusted population alone from RV Scale X age-sex adjusted population distribution.

The negative impact of the scales for some health regions, such as RV Scales Utilization and Need for RHA04 (Calgary), and RV Scale Utilization for RHA10 (Capital), does not necessarily mean that the funding is reduced from current levels. Current fund allocation in Alberta is not population based and has no established formula.

Because the scales are based on standardized rates, they can be applied directly to future populations adjusted for age-sex, using provincial level utilization rates. Since the relative value scales have the lowest value set to 1.000, they are readily interpreted and can be applied directly to populations through multiplication. The overall impact of SES RV Scale Need on an initial age-sex per capita allocation is 4.6 percent or $85 million of a hypothetical $2 billion regional health budget. The overall impact of SES RV Scale Utilization is 18.9% or $379 million of a hypothetical $2 billion budget.

SES RV Scale Need, displayed in table 7b, results in a fund allocation of 26.31% to RHA04 (Calgary) and 26.29% to RHA 10 (Capital). The allocation of age-sex per capita alone is 28.04% and 26.69% respectively. Thus applying this scale would have a negative impact beyond an initial age-sex adjusted per capita allocation for RHA04 (Calgary) and RHA10 (Capital). Table 7b shows the percentage change from an initial age-sex per capita allocation specific to each RHA. Most RHAs gain or lose less than 5% beyond the age-sex adjusted per capita allocation.

Three RHAs however gain much more significantly. RHA13 (Mistahia), RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) gain 8.15%, 42.61% and 39.64% respectively. RHAs Keeweetinok Lake and Northwestern are quite unique in terms of having very high aboriginal and poorly educated population components. Additionally, they experience negative impacts from the initial age-sex adjustment largely because aboriginals have a shorter lifespan.

The application of SES RV Scale Utilization, displayed in table 7a, provides an allocation of 21.96% to RHA04 (Calgary) and 23.41% to RHA10 (Capital). The allocations are considerably less than either age-sex per capita, or age-sex per capita multiplied by SES RV Scale Need, allocations. This is due to the relatively low levels of utilization for these two RHAs.

On the other hand, many RHAs make considerable gains with SES RV Scale Utilization. RHA14 (Peace), RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) have increases of 49.47%, 129.20% and 203.97% respectively. The percentage change for most health regions is near 20% as compared to near 5% with SES RV Scale Need.

SES RV Scale Utilization is based on utilization data with a much greater degree of variability (3 to 4 times greater) than SES RV Scale Need. SES RV Scale

Utilization is highly indicative of past acute care utilization because the actual rates used were explained, statistically, 88%.

The findings indicate significant differences may occur when moving to a model that is population based and needs based, even though the need measure is based in units of utilization. At the same time, one intention of a population needs based funding model is to reduce unusually high rates of utilization where possible, and provide a fair distribution of limited dollars. Thus the needs of one region are met only in relation to other regions. Given the above findings, a transitional model may be necessary in moving to a population needs based funding model.

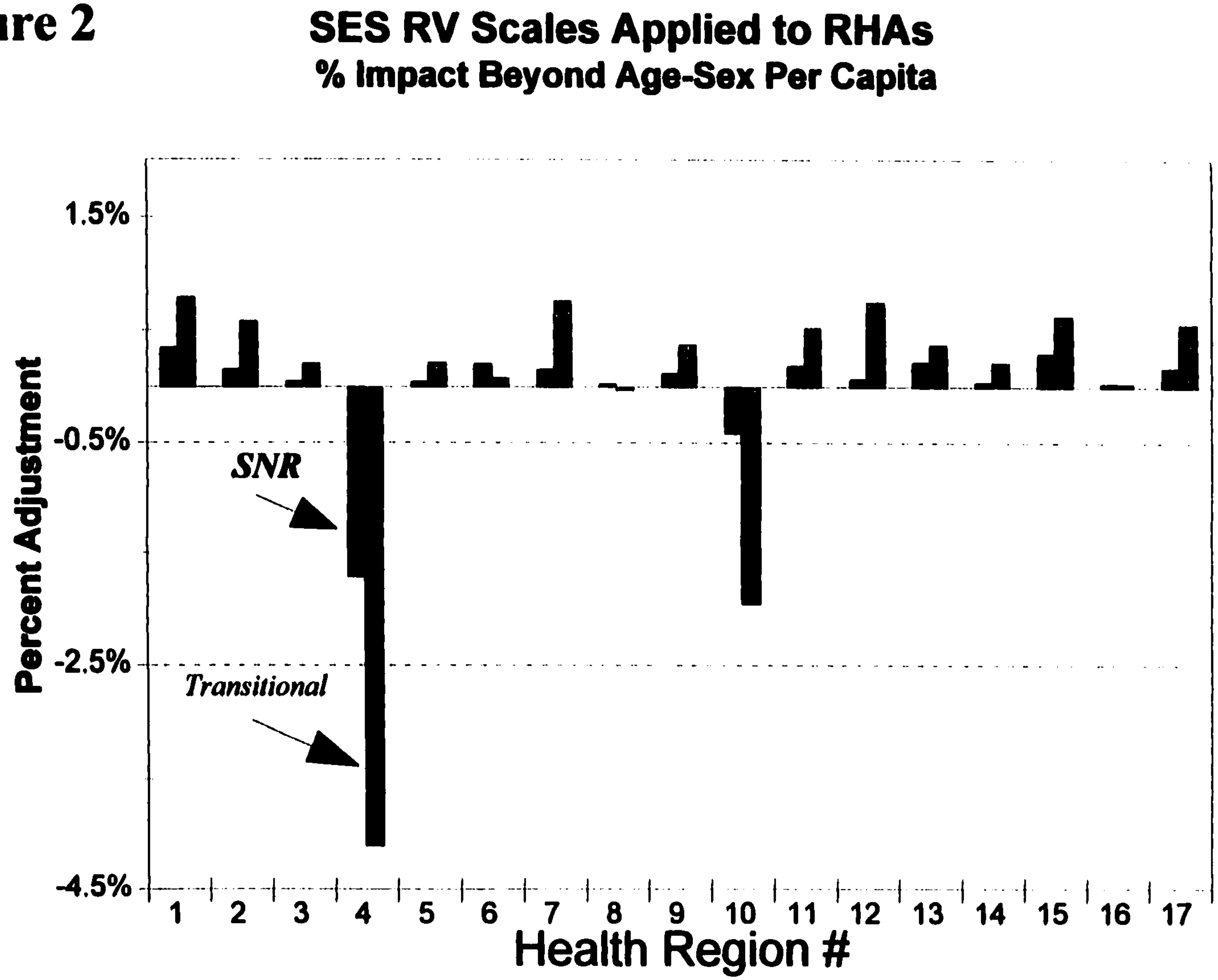
A Transitional SES RV Scale based on combining the need and utilization scales was developed. A factor of .5 was applied to the values of both scales. Table 7c displays the output from applying Transitional SES RV Scale. Health regions with relatively low rates of past utilization, such as RHA04 (Calgary) and RHA10 (Capital), would continue to receive decreases beyond the initial age-sex per capita allocation, but the decreases wouldn't be as great. It is important to realize that these two larger regions do not necessarily lose funds from what they are currently receiving for the service populations within their regional boundaries.

Figure 2 provides a graph of the percentage change beyond age-sex per capita that occurs for each region under SES RV Scale Need and Transitional SES RV Scale. The horizontal axis represents the age-sex adjusted per capita allocation for each RHA. This is the starting point from which the impact of the scales is measured. Due to the large population size, but high level of SES, RHA04 (Calgary)

Table 7c

Transitional Relative Value Scale (.5 SUR & .5 SNR) Applied to Alberta Health Regions									
Health Region Name	HR #	Population	Relative Value Scale	%Budget Allocation		% Change Region Specific	% Change Overall Budget	Impact on a $ 2B Budget	
		'94 Age-Sex Adjusted (000		Age-Sex Adjusted	RV Scale Applied			$ Total Impact (000)	$ Per Capita Impact
Chinook	01	165.979	1.321	6.22%	7.01%	12.76%	0.79%	$15,872	$96
Palliser	02	92.797	1.367	3.48%	4.06%	16.72%	0.58%	$11,631	$125
Headwater	03	64.810	1.272	2.43%	2.64%	8.65%	0.21%	$4,200	$65
Calgary	04	748.061	1.000	28.04%	23.94%	-14.62%	-4.10%	($81,954)	($110)
Health Region 5	05	55.569	1.290	2.08%	2.29%	10.10%	0.21%	$4,209	$76
David Thompson	06	178.169	1.185	6.68%	6.76%	1.21%	0.08%	$1,610	$9
East Central	07	125.491	1.362	4.70%	5.47%	16.31%	0.77%	$15,340	$122
Westview	08	66.871	1.153	2.51%	2.47%	-1.51%	-0.04%	($757)	($11)
Crossroads	09	70.934	1.338	2.66%	3.04%	14.20%	0.38%	$7,552	$106
Capital	10	712.192	1.085	26.69%	24.72%	-7.39%	-1.97%	($39,444)	($55)
Aspen	11	80.243	1.375	3.01%	3.53%	17.38%	0.52%	$10,457	$130
Lakeland	12	162.931	1.316	6.11%	6.86%	12.34%	0.75%	$15,069	$92
Mistahia	13	71.624	1.335	2.68%	3.06%	13.99%	0.38%	$7,513	$105
Peace	14	19.445	1.518	0.73%	0.94%	29.59%	0.22%	$4,314	$222
Keeweetinok Lake	15	18.627	2.223	0.70%	1.33%	89.81%	0.63%	$12,540	$673
Northern Lights	16	22.911	1.219	0.86%	0.89%	4.09%	0.04%	$702	$31
Northwestern	17	11.510	2.684	0.43%	0.99%	129.21%	0.56%	$11,148	$969
Alberta Rates/Sums		2,668.164	1.169	100.00%	100.00%	100.00%	12.23%	$244,311	$92
								$2B / 2668.164 =	$750

Figure 2


SES RV Scales Applied to RHAs
% Impact Beyond Age-Sex Per Capita
1.5%
-0.5%
-2.5%
-4.5%
Percent Adjustment
SNR
Transitional
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
Health Region #

reduces the most from the application of the scales. RHA10 (Capital) has an older population than RHA04 (Calgary) and therefore its age-sex adjusted population is increased. Since it has poorer SES than RHA Calgary its high age-sex adjusted population is multiplied by a positive factor for SES. RHA10 (Capital) therefore reduces less than RHA04 (Calgary). For most other RHAs there is a positive impact beyond the initial allocation by age-sex per capita.

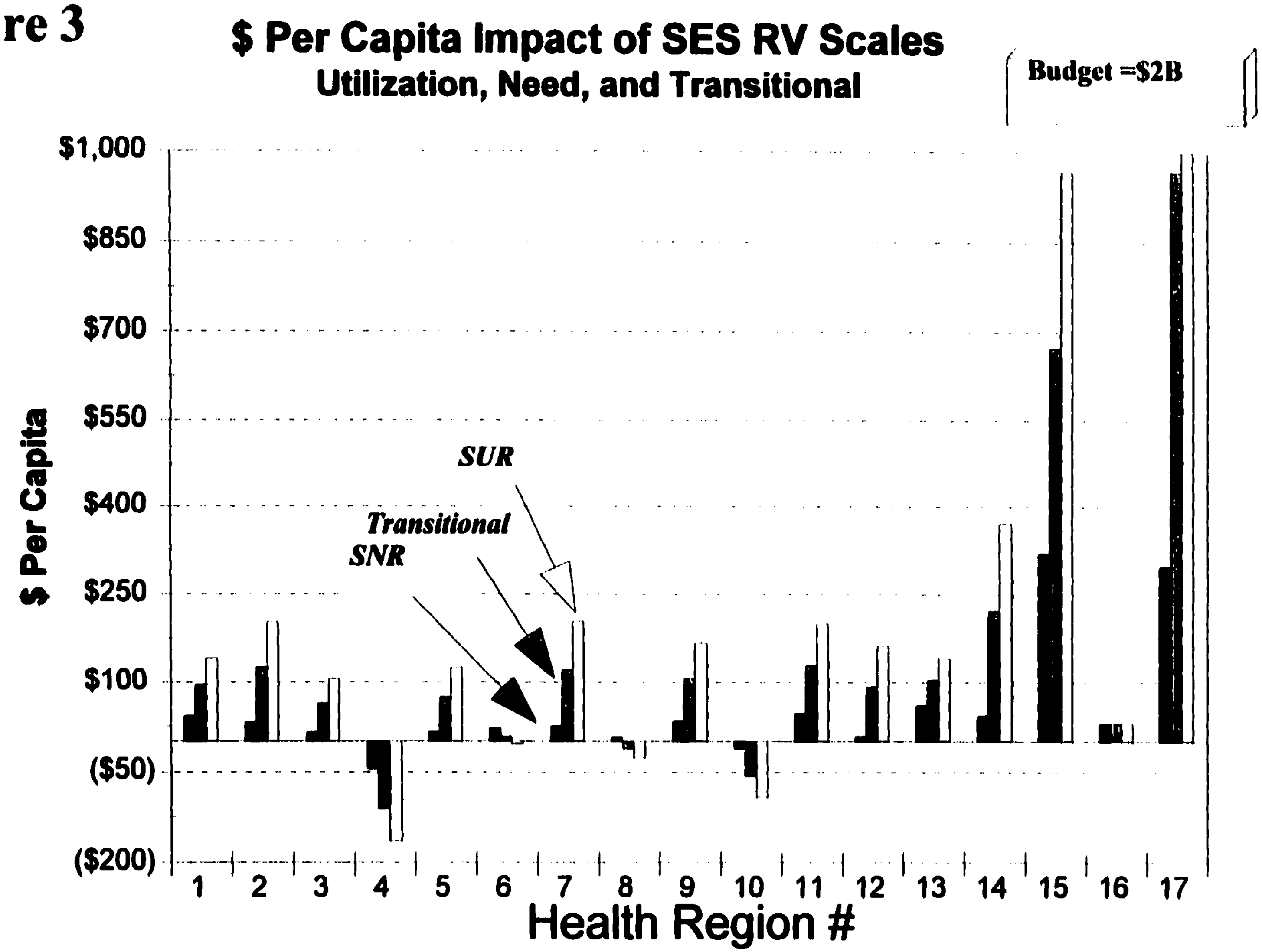
Figure 3 shows the impact of the three SES RV Scales from a dollar per age-sex adjusted capita perspective. The dollar per capita figures are from Tables 7a, 7b, and 7c, using a $2 billion hypothetical regional health budget. The horizontal axis is the per capita amount for the 1994 age-sex adjusted population, or $750 per Albertan. The average dollar impact per RHA, for SES RV Scale Need, is an increase of $32 per capita. RHA04 (Calgary) would reduce by $46, RHA10 (Capital) by $11. RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) gain $319 and $297 respectively, beyond age-sex adjusted population. Again, it must be pointed out that these impacts are beyond age-sex adjusted per capita alone and not from current levels of fund allocation.

4.5 Summary of Findings

The major findings are:

(1) The descriptive findings confirmed the validity of breaking down large health regions and aggregating smaller ones by using federal electoral district (FED) as the geographic unit. Population size ranged from 14,980 in RHA15

Figure 3


$ Per Capita Impact of SES RV Scales
Utilization, Need, and Transitional
Budget =$2B
$1,000
$850
$700
$550
$400
$250
$100
($50)
($200)
$ Per Capita
SUR
Transitional
SNR
1
2
3
4
5
6
7
8
9
10
11
12
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15
16
17
Health Region #

(Keeweetinok Lake) to 753,814 in RHA04 (Calgary) for a max/min ratio of 50.32. At the federal electoral district level, population size ranged from 72,535 in FED02 (Beaver River) to 128,590 in FED04 (Calgary North) for a max/min ratio of 1.86.

(2) Wide variation was found across the small areas (FEDs) for Standardized Utilization Rate (SUR), Standardized Need Rate (SNR), SMR75, and SES variables. Max/min ratios were 2.25 for SUR, 1.34 for SNR, 2.38 for SMR75, 43.27 for %ABORIG, 5.22 for %GRADE9, 1.93 for $TICAP and 5.05 for %PERSLOW.

(3) Using both Pearson correlation for continuous level measurement and Spearman rank order correlation for ordinal measurement, SMR75 was found **not** to have a statistically significant correlation, at the .05 level, with the dependent variables of utilization (SUR) and need (SNR).

(4) SMR75 reached statistically significant correlations with SES variables, including %ABORIG (Pearson, .39; Spearman, .63) %UNRATE (Pearson, .46), %GRADE9 (Pearson, .41), and %FAMLOW (Pearson, .41).

(5) Strong statistically significant associations were found between SUR and SES variables. Correlations above .50 were found with $TICAP, %ABORIG, %GRADE9, and %GRADE12 for both correlation procedures.

(6) Correlations were also strong between SNR and SES variables, remaining .50 and higher for the variables of $TICAP, %ABORIG, %GRADE9, and %GRADE12.

(7) The correlation between $TICAP with utilization and need measures was negative, indicating that areas with low income per capita both use and need more health services than areas with higher income per capita. While correlations did not reach statistical significance with %UNRATE and SUR or SNR, the direction of the correlation shifted from negative for SUR to positive for SNR. This finding may indicate that areas with high levels of unemployment tend to utilize less resources but may need more. The Pearson correlation increased by 38% from the association of %UNRATE with SUR to %UNRATE with SNR.

(8) For SMR75, using stepwise regression analysis, 21% of the variation among geographic areas was accounted for by %UNRATE.

(9) Using stepwise regression analysis, 88% of variation in Standardized Utilization Rate (SUR) across geographic areas was accounted for by the SES measures of %ABORIG, %GRADE9, and %UNRATE. Sixty-six (66) percent of variation in Standardized Need Rate was accounted for by the SES measures of %ABORIG, %PERSLOW, and %GRADE12.

(10) Applying expected values from the small area regression models to health regions resulted in relative values (based on SES association) for each health region. SES RV Scale Utilization and SES RV Scale Need were calculated from the relative values.

(11) With the need model, RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) have SES need rates approximately 50% greater than the health region with

the highest socioeconomic status (RHA04, Calgary). RHA10 (Capital) has a need rate based on SES that is 4.9% higher than RHA04 (Calgary).

(12) Variation across geographic areas for utilization (SUR) and need (SNR) rates at the small area level, was high. For SUR the max/min ratio was 2.25; for SNR the max/min was 1.35. At the health region level, the max/min ratio increased significantly to 3.87 for SUR, and increased slightly to 1.55 for SNR.

(13) While variation in utilization and need rates among health regions can be largely explained by SES, the model based in need (SNR) is very different from the one based in utilization (SUR). The SNR model is built from a data set that includes only 38% of total acute care utilization data. Total utilization data is not appropriate as a measure of need.

(14) While SES accounted for variation in utilization rates and need rates across small geographic areas 88% and 66% respectively, the stronger association of SES with the utilization rate cannot be interpreted as meaning that past levels of utilization are justified and the relationships cannot be interpreted as causal. Utilization data has serious weaknesses, primarily the incorporation of professional uncertainty.

(15) Implementing the needs based model (SNR), without a transitional period, may result in undue strain on those health regions impacted most. Some regions would likely need to make great shifts from what their historic levels of acute care utilization would indicate, and from their initial age-sex adjusted

per capita allocation. A transitional SES RV Scale was constructed to help reduce the impact. It was developed by applying a factor of .5 to both SES RV Scale Need and SES RV Scale Utilization. The max/min ratio for Transitional SES RV Scale is 2.69, which reduced from 3.87 for the SUR model.

(16) The overall impact of SES RV Scale Need, SES RV Scale Transitional, and SES RV Scale Utilization, is \$85 million (4.6%), \$244 million (12.2%), and \$379 million (18.9%), respectively, on a hypothetical regional health budget of \$2 billion.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Thesis

The purpose of this thesis was to examine the relationships among measures of socioeconomic status (SES), health status, and health service utilization using small area analysis. The purpose was also to use the findings to explore the possibility of allocating funds to health regions beyond an age-sex adjusted per capita basis.

Most existing models for measuring health need have taken an epidemiologically oriented approach, which appears not to provide adequate association with resource based measures. Yet resource based measures are required for fund allocation purposes. This thesis found SES to be stronger than standardized mortality ratio (less than 75 years) at predicting health need based on resource measures.

Acute care utilization data were used to develop the measure of resource need. It was assumed, based on findings from the literature review, that acute care cases were less impacted by uncertainty in decision making and availability of services in the community. Adjacent Diagnosis Related Group (ADRG) categories of illness were used to select cases, from the hospital abstract files for Alberta, that were least likely to exhibit professional uncertainty in making the decision to hospitalize the patient. This selection was undertaken by a physician and professor in the Public Health Sciences department, University of Alberta, with an extensive background in acute care. Resource weights, associated with the Refined Diagnosis Related Group (RDRG) categories of illness, were used to estimate resource units per hospital admission.

As Alberta Health Regions (RHAs) had wide variation in population size, which would contribute to distortion of results for use in regression models, federal electoral district (FED) provided a level at which the analysis would be more free from variation in population size. SES variables displayed considerable variation. Variation was also high for age-sex standardized utilization rates, but reduced significantly when professional uncertainty was controlled for.

Areas with populations displaying a high percentage of poorly educated population, low income, and high aboriginal component, were found to both use and need a greater degree of health resources relative to other areas. Using stepwise regression analyses, SES was found to account for 88% of variation in the standardized utilization rate and 66% of variation in the standardized need rate across small areas (FEDs).

The regression models were applied to the SES variables at the health region level. Expected values from the application of the regression equations were converted into SES Relative Value Scale Utilization and SES Relative Value Scale Need. Variation across the two sets of rates was quite different, confirming the assumption that attempting to control for professional uncertainty in the data was necessary. When SES RV Scale Need was applied to an age-sex adjusted population, some health regions would need to make adjustments that may be too great without a transitional period.

5.2 Findings

The major findings of the thesis are:

(1) The literature suggested income, education, occupational status, unemployment, aboriginals, and single parent families as major variables to use in developing a model that associates socioeconomic status (SES) with measures of health service utilization and health need. This thesis found these variables correlated significantly with total acute care utilization, and, selected acute care utilization when controlling for professional uncertainty.

(2) The literature showed value in using standardized mortality ratio (SMR) as a proxy for health need associated with morbidity, but indicated SMR may not necessarily reflect health need associated with resource use. This assessment was confirmed by the thesis using deaths for the total population and the less than 75 year population.

(3) When the purpose of a health need model is fund allocation, recent literature supports the use of utilization data to measure need.

(4) A number of researchers are critical of using utilization data for measures because of the bias contained in the data. The bias is due largely to professional uncertainty in decision making. Practice style, availability of

services, admission criteria and physician incentives are additional elements contributing to bias in the data.

(5) Studies that have used specific types of cases to more accurately measure variation in utilization rates across geographic areas have been limited to surgical and medical acute care cases. These studies have clearly demonstrated an association between variation in utilization rates and degree of complexity and severity of the type of case. Cases of higher complexity and severity display lower variation in utilization. Some researchers have attributed this finding to the degree of professional uncertainty involved in decision making.

(6) For this thesis, Adjacent Diagnosis Related Group (ADRG) categories provided a mechanism to select acute care hospital cases. Refined Diagnosis Related Group Weights (RDRGWs) provided estimated resource units that are more accurate than hospital patient-days or hospital admissions.

(7) This thesis confirmed the need to break down larger health regions and aggregate smaller health regions. Population size had a max/min ratio of 50.32 for RHAs and 1.89 for FEDs.

(8) Wide variation was found across the small areas (FEDs) for age-sex standardized acute care utilization rate (SUR), age-sex standardized need rate (SNR), standardized mortality ratio (SMR) for the under 75 year population, and SES variables. Max/min ratios were 2.25 for SUR, 1.35 for

SNR, 2.38 for SMR less than 75 years, 43.27 for percent of population that is aboriginal, 5.22 for percent of 15 year and older population with less than grade nine education, 1.93 for total income per capita, and 5.05 for percent of persons in households with incomes below the Statistics Canada Low Income Cut-Offs.

(9) Pearson correlation for continuous level measurement and Spearman rank order correlation for ordinal level measurement were applied to the variables in the study. Standardized mortality ratio (less than 75 years) was found to not have a statistically significant correlation, at the .05 level, with the dependent variables of utilization rate (SUR) and need rate (SNR).

(10) Standardized mortality ratio (less than 75 years) reached statistically significant correlations with the SES variables: percent of population that is aboriginal (Pearson, .39; Spearman, .63), unemployment rate (Pearson, .46), percent of 15 year and older population with less than grade nine education (Pearson, .41), and percent low income families (Pearson, .41).

(11) Strong associations with SES variables were found for both the SUR and SNR dependent measures. Pearson and Spearman correlations were above .50 with total income per capita, percent population that is aboriginal, percent of 15 year and older population with less than grade nine education, and percent of 15 year and older population with less than grade twelve education.

(12) The correlations between total income per capita and the dependent measures of need and utilization were negative, indicating that areas with low income per capita both use and need more health services than areas with higher income per capita.

(13) While correlations did not reach statistical significance between the unemployment rate and SUR or SNR, the direction of the correlation shifted from being negative for SUR to positive for SNR. This finding may indicate that areas with high levels of unemployed populations tend to utilize less resources but need more, indicating a behavioural element to health service utilization.

(14) Using stepwise regression analysis, unemployment rate was the only predictor variable for standardized mortality rate (less than 75 year population). An R-square value of .21 was reached.

(15) Using stepwise regression analysis, the predictor variables for standardized utilization rate (SUR) were percent population that is aboriginal, percent of 15 year and older population with less than grade nine education, and the unemployment rate. This model reached an R-square value of .88, accounting for 88% of the variation among small areas.

(16) For standardized need rate (SNR) the predictor variables were percent of population that is aboriginal, percent of persons living below Statistics Canada Low Income Cut-Offs, and percent of 15 year and older population

with less than grade twelve education. This model reached an R-square value of .66, accounting for 66% of the variation among small areas (FEDs).

(17) Applying expected values from the regression models to the health region level resulted in relative values or weights for health regions. SES RV Scale Utilization and SES RV Scale Need were calculated from the relative values. With the need model, RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) have need rates, explained by SES, approximately 50% greater than the health region with the highest socioeconomic status (RHA04, Calgary).

(18) Based on a $2 billion regional health budget, SES RV Scale Need would re-distribute $85 million (4.6%) beyond age-sex adjusted per capita; SES RV Scale Utilization would re-distribute $379 million (18.9%).

(19) Transitional SES RV Scale was developed by applying a factor of .5 for both RV Scales. The transitional model would re-distribute $244 million (12.2%) of a hypothetical $2 billion regional health budget.

5.3 Conclusions

The findings of this thesis validate the controversy in the literature surrounding the use of SMR in health service funding models, and support the use of SES variables instead. SES plays a more significant role than SMR when the dependent measure of need is based on units of utilization.

SES variables and selected utilization rates can be used to develop relative values by associating them in a stepwise regression model. For Alberta, the small areas can be federal electoral districts. The regression equations can then be applied to SES data aggregated to the level of health region for a fund allocation model. The model would be improved by using a higher number of geographic areas, but the population size in each must be large enough to produce stable rates and percentage values.

An attempt to remove professional uncertainty from utilization data is important if the measure is to be a valid and accurate representation of relative need. This element will continue to be most difficult in developing SES adjustment models. Possibly the best solution will be the long term one of making significant attempts to reduce professional uncertainty and practice style at the assessment and treatment level, especially through the implementation of standards of practice.

A major coordination of information would be required to determine the extent to which various health services are influenced by SES variables beyond established utilization patterns and beyond the displacement effect of one health service upon another across geographic areas. The addition of other services to the models that have been developed in this thesis may provide a different effect from that which was found. However, controlling for professional uncertainty will be theoretically more difficult.

5.4 Limitations

An overall methodological limitation of this study was that all data sources were secondary and thus had to be used as they were. This included having to match data sets from various sources using postal codes. Some data would be lost in the matching process. Secondary data usually has some error in accuracy and data entry. A significant limitation with secondary data is that it restricts a study to those variables on which data were collected. Thus the resource utilization measure was estimated units per acute care separation: actual cost data per episode of illness is not collected in Canada.

The study made the assumption, although based on the literature, that acute care cases provide the most valid and accurate form of utilization data as they are least likely to be biased by elements of professional uncertainty and availability of services.

The procedure used in this study for retrospectively selecting cases for certainty to hospitalize may have been biased, to some extent, by the subjectivity of the individual physician/professor who carried out this process.

This thesis provides only the SES adjustment element of a complete population needs based funding model. Policy must also be in place for re-imbursement or adjustment for cross region utilization. As well, adjustment for providing service in remote areas both in relation to lack of economies of scale and access costs, such as travel for professionals, need to be developed. Policy for inappropriate referrals between regions should be part of a complete funding model.

5.5 Recommendations

Based on the findings, interpretations, and conclusions from the research, the following recommendations are made for health funding policy and further research.

5.5.1 Alberta Health Policy

Alberta Health should include an adjustment for SES in addition to its initial allocation by age-sex adjusted per capita. Standardized mortality ratio should not be considered. SES RV Scale Need or Transitional SES RV Scale, developed in this thesis, could be used for this purpose.

Alberta Health should collect basic socioeconomic data on its health registry files. Given the movement to a population needs based model and regionalization of services, the public may be receptive to this requirement. Alternatively, Alberta Health should weigh the costs and benefits of updating socioeconomic data in the form of a census to take place between the Canada census years. It may be possible for municipalities to share in the cost and not conduct a civic census.

Using models developed in this thesis, Alberta Health would need to calculate an age-sex adjusted population each year for RHAs using Alberta health registry data, weighted by provincial level age-sex utilization rates, for the various health services that would be included under RHA management. SES RV Scale Need or the transitional scale would then be applied.

Alberta Health needs to determine which services should be exempt from regional funding. Highly specialized services that are provided entirely in the central metropolitan regions should probably be under a separate funding mechanism.

Cross-region utilization must be addressed. In particular, policy as to whether or not an allocation is to be based on an estimate for cross-region utilization at the start of a budget year, or whether re-imbursement should take place when the service is provided. Additionally, the question of whether or not re-imbursement is to be prospective or retrospective would need to be dealt with.

Policy should also be considered for inappropriate referrals. There may emerge an incentive to refer patients too readily into the central metropolitan regions when the service could have been provided in the patient's region of origin. Cases of higher complexity in particular have an increased risk of becoming more complex. Professional uncertainty and the acceptance of variation in practice style can mask what may be a purposeful effort to influence professionals to refer cases on that are likely to incur unknown additional cost. It may be appropriate to have monitoring systems and policy in place for this possibility.

Policy must also be in place to address the additional costs that are part of providing service in remote areas. These additional costs include the elements of lack of economy of scale relative to more urban areas and the geographic distance element.

If preventive service funds are to be allocated from a separate fund, then it would be appropriate to adjust an age-sex per capita allocation according to the need model developed in this thesis. In this way preventive service funding would be focused more on need associated with SES. Having preventive dollars associated closely with SES may be a sound approach based on the findings from the literature review undertaken for this thesis.

Alberta Health should consider re-drawing the RHA boundaries and allow the decisions to be based more on the natural service areas that are present. A re-drawing of regional boundaries should be done in a way that would limit the estimation, monitoring and re-imbursement that would occur for cross-region utilization. While analysis is required to determine the natural service areas, it is likely the case that RHA10 (Capital) should include Sherwood Park, Leduc, Stony Plain and Spruce Grove.

Once allocations are provided to all RHAs by first age-sex adjusted population weighted by current utilization rates, followed by SES adjustment, followed by adjustment for cross-region utilization, and remoteness, the allocation to RHA15 (Keeweetinok Lake) and RHA17 (Northwestern) should be carefully assessed. Management of the health of the populations in these two regions likely requires awareness of cultural and service provision peculiarities that are not captured completely in a statistical funding model. There may be interactions among culture, deprivation, and utilization peculiarities that result in cost drivers the system is currently unaware of. Additionally, these two regions should not be penalized by the shorter life span of their native populations which reduces the population counts following age-sex adjustment. Due to very low population size, vast geographic area, cultural uniqueness, and highly deprived status with respect to socioeconomic indicators, these two regions should likely have special recognition over an acceptable transitional period in moving to the recommended funding model.

5.5.2 Further Research

The following additional research, and refinement of models developed in this thesis, is recommended:

(1) The degree to which the SES models can explain utilization and need for health services beyond acute care should be examined. However, the effort to remove the bias from professional uncertainty and availability of service, may be more difficult.

(2) Refinement through testing other SES measures, including occupational status, should be pursued.

(3) When 1996 census data become available, the questions asked on activity limitation should be tested in the models to provide a health status measure beyond SMR.

(4) The geographic unit for analysis used in this thesis should be further explored. Some combination of federal electoral district, grouped neighbourhoods, and small municipalities, should be considered. One of the reasons for selecting federal electoral district as the unit was to provide stable ratios for SMR. Since SMR has been shown to not be as useful an indicator

as SES, a reduction in population size per geographic unit can more reasonably be considered.

(5) The model should be replicated with data from other provinces.

(6) Further research should attempt to incorporate a variable for urbanization. If a continuous level variable cannot be possible then possibly a discrete level variable, with values 0 and 1, could be created to distinguish those small areas that are within a central metropolitan area from those which are not. A larger number of small areas may allow a discrete variable to become useful in the models.

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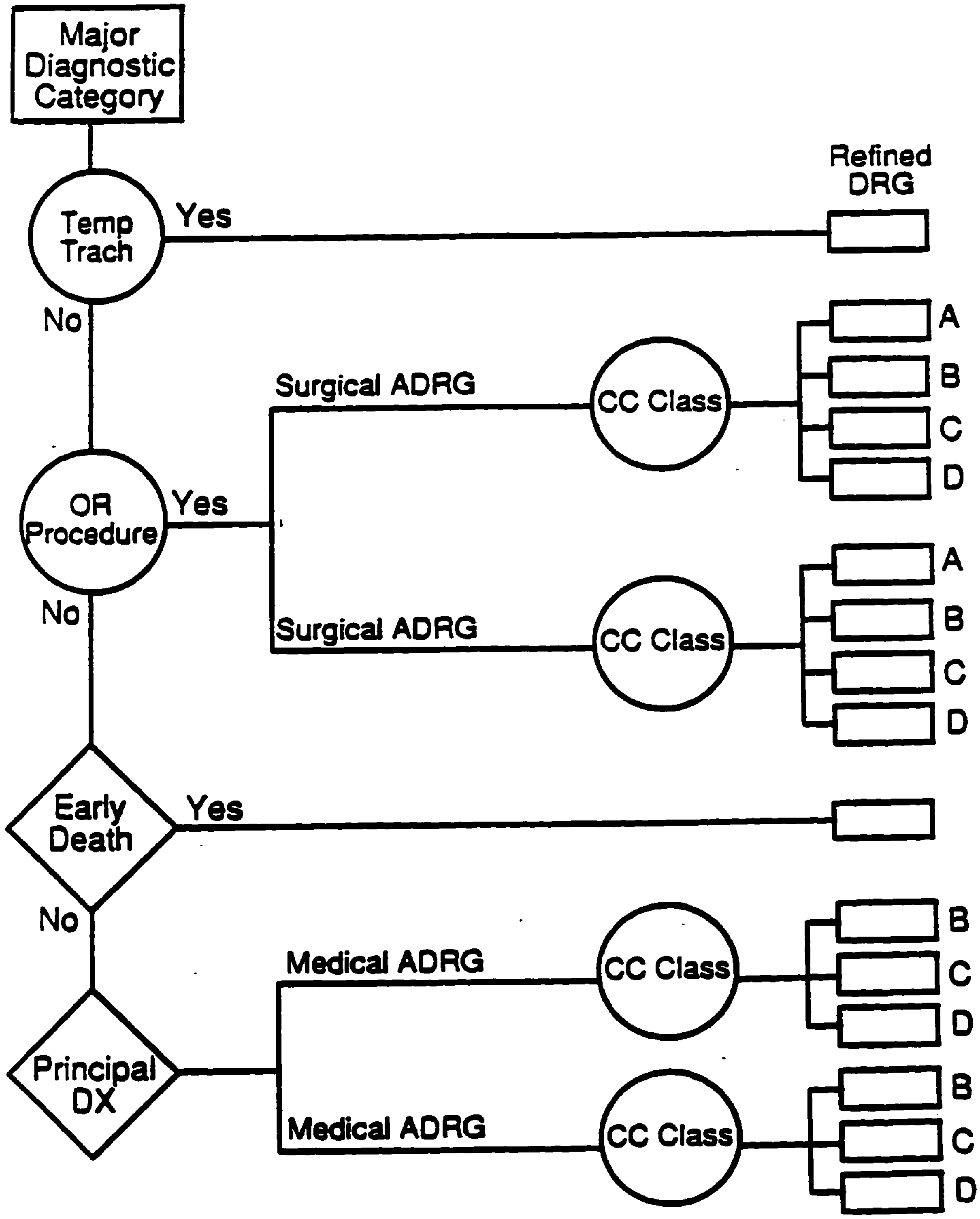
APPENDIX A

ADRG and RDRG Category Schematic

Structure of Refined DRG Classification



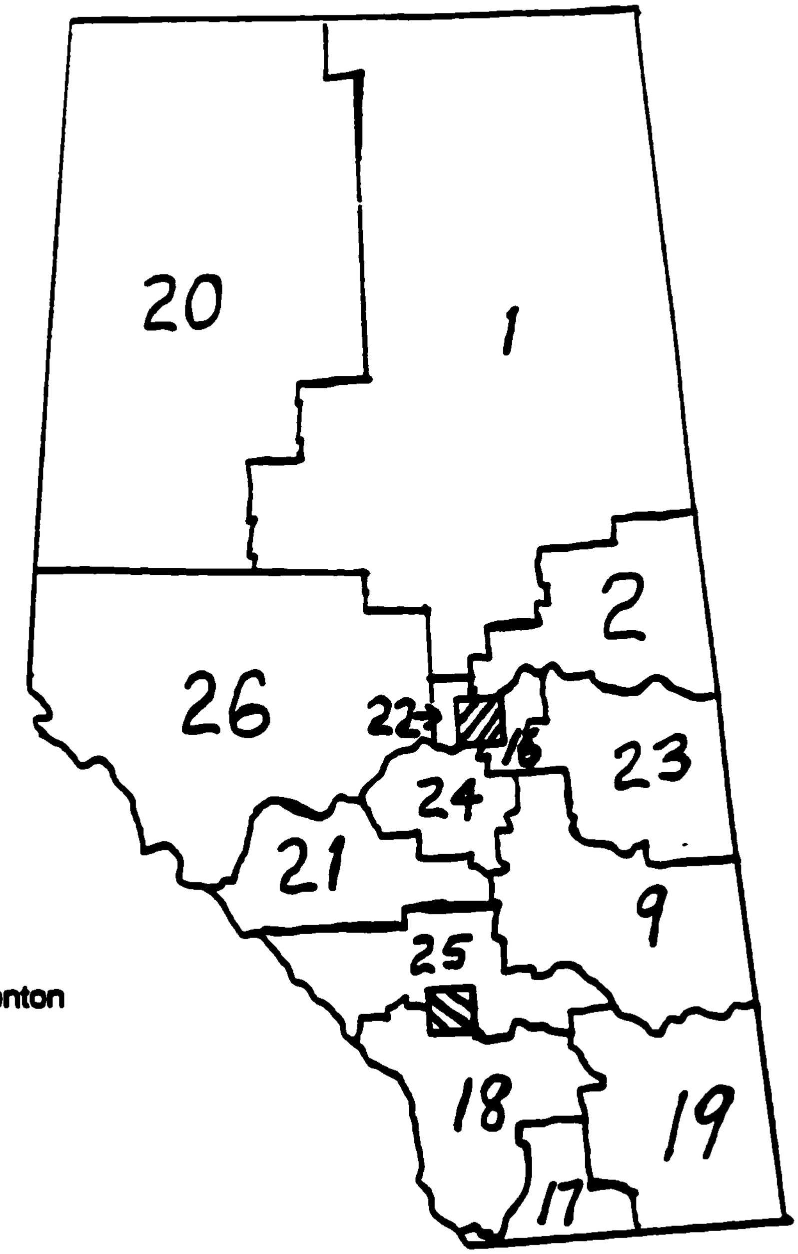
Source: RDRGs: Refined Diagnostic Related Groups, Version 2.3 Definition Manual. 1990. Health Systems Management Group, School of Medicine. New Haven: Yale University.

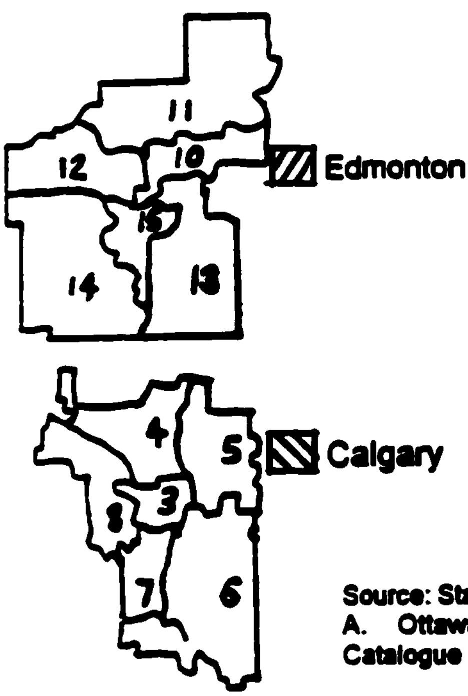
APPENDIX B

Map and List of Federal Electoral Districts in Alberta

Federal Electoral Districts in Alberta

01 Athabasca
02 Beaver River
03 Calgary Centre
04 Calgary North
05 Calgary Northeast
06 Calgary Southeast
07 Calgary Southwest
08 Calgary West
09 Crowfoot
10 Edmonton East
11 Edmonton North
12 Edmonton Northwest
13 Edmonton Southeast
14 Edmonton Southwest
15 Edmonton Strathcona
16 Elk Island
17 Lethbridge
18 Macleod
19 Medicine Hat
20 Peace River
21 Red Deer
22 St. Albert
23 Vegreville
24 Wetaskiwin
25 Wild Rose
26 Yellowhead





Source: Statistics Canada. (1992). Profile of federal electoral districts, part A. Ottawa: Supply and Services Canada. 1991 Census of Canada. Catalogue number 93-335. (Modified by author).

APPENDIX C

Map and List of Alberta Health Regions

APPENDIX D
ADRG Categories with Professional Uncertainty to Hospitalize

ADRG TITLES AND PROFESSIONAL UNCERTAINTY

PROF: 1=YES, Uncertainty to hospitalize
2=NO, No uncertainty to hospitalize

ADRG	PROF	DESCRIPTION
1	2	CRANIOTOMY EXCEPT FOR TRAUMA
2	2	CRANIOTOMY FOR TRAUMA
4	1	SPINAL PROCEDURES
5	2	EXTRACRANIAL VASCULAR PROCEDURES
6	1	CARPAL TUNNEL RELEASE
7	1	PERIPH & CRANIAL NERVE & OTHER NERV PROC
9	1	SPINAL DISORDERS & INJURIES
10	1	NERVOUS SYSTEM NEOPLASMS
12	1	DEGENERATIVE NERVOUS SYSTEM DISORDERS
13	1	MULTIPLE SCLEROSIS & CEREBELLAR ATAXIA
14	2	SPECIFIC CEREBROVASCULAR DIS EXCEPT TIA
15	1	TIA & PRECEREBRAL OCCLUSIONS
16	1	NONSPECIFIC CEREBROVASCULAR DISORDERS
18	1	CRANIAL & PERIPHERAL NERVE DISORDERS
20	2	NERVOUS SYS INFECT EXCEPT VIRAL MENINGITIS
21	1	VIRAL MENINGITIS
22	2	HYPERTENSIVE ENCEPHALOPATHY
23	1	NONTRAUMATIC STUPOR & COMA
24	1	SEIZURE & HEADACHE
27	2	TRAUMATIC STUPOR & COMA, COMA >1 HR
28	1	TRAUMATIC STUPOR & COMA, COMA <1 HR
31	1	CONCUSSION
34	1	OTHER DISORDERS OF NERVOUS SYSTEM
36	1	RETINAL PROCEDURES
37	2	ORBITAL PROCEDURES
38	1	PRIMARY IRIS PROCEDURES
39	1	LENS PROCEDURES WITH OR WITHOUT VITRECTOMY
40	1	EXTRAOCULAR PROCEDURES EXCEPT ORBIT
42	1	INTRAOCULAR PROC EXC RETINA, IRIS & LENS
43	1	HYPHEMA
44	1	ACUTE MAJOR EYE INFECTIONS
45	1	NEUROLOGICAL EYE DISORDERS
46	1	OTHER DISORDERS OF THE EYE
49	2	MAJOR HEAD & NECK PROCEDURES
50	1	SIALOADENECTOMY
51	1	SALIVARY GLAND PROC EXCEPT SIALOADENECTOMY
52	2	CLEFT LIP & PALATE REPAIR

ADRG	PROF	DESCRIPTION
53	1	SINUS & MASTOID PROCEDURES
55	1	MISC EAR, NOSE, MOUTH & THROAT PROCEDURES
56	1	RHINOPLASTY
57	1	T&A PROC, EXC TONSILL &/OR ADENOID ONLY
59	1	TONSILLECTOMY &/OR ADENOIDECTOMY ONLY
61	1	MYRINGOTOMY W TUBE INSERTION
63	1	OTHER EAR, NOSE, MOUTH & THROAT O.R. PROC
64	1	EAR, NOSE, MOUTH & THROAT MALIGNANCY
65	1	DYSEQUILIBRIUM
66	1	EPISTAXIS
67	1	EPIGLOTTITIS
68	1	OTITIS MEDIA & URI
71	1	LARYNGOTRACHEITIS
72	1	NASAL TRAUMA & DEFORMITY
73	1	OTHER EAR, NOSE, MOUTH & THROAT DIAGNOSES
75	2	MAJOR CHEST PROCEDURES
76	1	OTHER RESP SYSTEM O.R. PROCEDURES
78	2	PULMONARY EMBOLISM
79	1	RESPIRATORY INFECTIONS & INFLAMMATIONS
82	1	RESPIRATORY NEOPLASMS
83	2	MAJOR CHEST TRAUMA
85	1	PLEURAL EFFUSION
87	2	PULMONARY EDEMA & RESPIRATORY FAILURE
88	1	CHRONIC OBSTRUCTIVE PULMONARY DISEASE
89	1	SIMPLE PNEUMONIA & PLEURISY
92	1	INTERSTITIAL LUNG DISEASE
94	2	PNEUMOTHORAX
96	1	BRONCHITIS & ASTHMA
99	1	RESPIRATORY SIGNS & SYMPTOMS
101	1	OTHER RESPIRATORY SYSTEM DIAGNOSES
103	2	HEART TRANSPLANT
104	2	CARDIAC VALVE PROC W PUMP & W CARD CATH
105	2	CARDIAC VALVE PROC W PUMP & W/O CARD CATH
106	2	CORONARY BYPASS W CARDIAC CATH
107	2	CORONARY BYPASS W/O CARDIAC CATH
108	2	OTHER CARDIOTHOR OR VASCULAR PROC, W PUMP
109	2	OTHER CARDIOTHORACIC PROCEDURES W/O PUMP
110	2	MAJOR RECONSTRUCTIVE VASC PROC W/O PUMP
112	2	VASCULAR PROC EXCEPT MAJOR RECONS W/O PUMP
113	2	AMPUT FOR CIRC SYSTEM EXC UPPER LIMB & TOE
114	2	UPPER LIMB & TOE AMPUTATION FOR CIRC SYS
115	2	PERM CARD PACE IMPL W/ AMI, HRT FAIL/SHK

ADRG	PROF	DESCRIPTION
116	1	PERM CARD PACE IMPL W/O AMI, HRT FAIL/SHK
117	1	CARD PACE REV EXC DEVICE REPLACEMENT
118	1	CARD PACE DEVICE REPLACEMENT
119	1	VEIN LIGATION & STRIPPING
120	1	OTHER CIRCULATORY SYSTEM O.R. PROCEDURES
121	2	CIRCULATORY DISORDERS W AMI
124	1	CIRCULATORY DISORDERS EXCEPT AMI
126	2	ACUTE & SUBACUTE ENDOCARDITIS
127	2	HEART FAILURE & SHOCK
128	2	DEEP VEIN THROMBOPHLEBITIS
129	2	CARDIAC ARREST, UNEXPLAINED
130	1	PERIPHERAL VASCULAR DISORDERS
132	1	ATHEROSCLEROSIS
134	1	HYPERTENSION
135	1	CARDIAC CONGENITAL & VALVULAR DISORDERS
138	1	CARDIAC ARRHYTHMIA & CONDUCTION DISORDERS
140	1	ANGINA PECTORIS
141	1	SYNCOPE & COLLAPSE
143	1	CHEST PAIN
144	1	OTHER CIRCULATORY SYSTEM DIAGNOSES
146	2	RECTAL RESECTION
148	2	MAJOR SMALL & LARGE BOWEL PROCEDURES
150	1	PERITONEAL ADHESIOLYSIS
152	1	MINOR SMALL & LARGE BOWEL PROCEDURES
154	1	STOMACH, ESOPHAGEAL & DUODENAL PROCEDURES
157	1	ANAL & STOMAL PROCEDURES
159	2	HERNIA PROC EXCEPT INGUINAL & FEMORAL
161	1	INGUINAL & FEMORAL HERNIA PROCEDURES
164	2	APPENDECTOMY W COMPLICATED PRINCIPAL DIAG
166	2	APPENDECTOMY W/O COMPLIC PRINCIPAL DIAG
168	1	MOUTH PROCEDURES
170	1	OTHER DIGESTIVE SYSTEM O.R. PROCEDURES
172	1	DIGESTIVE MALIGNANCY
174	1	G.I. HEMORRHAGE
176	1	COMPLICATED PEPTIC ULCER
177	1	UNCOMPLICATED PEPTIC ULCER
179	1	INFLAMMATORY BOWEL DISEASE
180	2	G.I. OBSTRUCTION
182	1	ESOPHAGITIS, GASTROENT & MISC DIGEST
185	1	DENTAL & ORAL DIS EXCEPT EXTRAC & RESTOR
187	1	DENTAL EXTRACTIONS & RESTORATIONS
188	1	OTHER DIGESTIVE SYSTEM DIAGNOSES

ADRG	PROF	DESCRIPTION
191	2	PANCREAS, LIVER & SHUNT PROCEDURES
193	1	BIL TR PROC EXC ONLY TOT CHOL W OR W/O CDE
195	1	TOTAL CHOLECYSTECTOMY W C.D.E.
197	1	TOTAL CHOLECYSTECTOMY W/O C.D.E.
199	1	HEPATOBILIARY DIAGNOSTIC PROC FOR MALIG
200	1	HEPATOBILIARY DIAG PROC FOR NON-MALIG
201	2	OTHER HEPATOBILIARY OR PANCREAS O.R. PROC
202	1	CIRRHOSIS & ALCOHOLIC HEPATITIS
203	1	MALIG OF HEPATOBILIARY SYS OR PANCREAS
204	1	DISORDERS OF PANCREAS EXCEPT MALIGNANCY
205	1	DISORDERS OF LIVER EXC MALIG,CIRR,ALC HEPA
207	1	DISORDERS OF THE BILIARY TRACT
209	2	MAJOR JOINT & LIMB REATTACHMENT PROCEDURES
210	2	HIP & FEMUR PROCEDURES EXCEPT MAJOR JOINT
213	2	AMPUTATION FOR MUSC SYS & CONN TISSUE
214	1	BACK & NECK PROCEDURES
216	1	BIOPSIES OF MUSC SYS & CONNECTIVE TISSUE
217	2	WND DEBRID & SKN GRFT EXC HAND, FOR MUSC
218	1	LOWER EXTREM & HUM PROC EXC HIP,FOOT,FEMUR
221	1	KNEE PROCEDURES
223	2	MAJOR SHOULDER/ELBOW PROC
224	1	OTHER SHOULD,ELB OR LOWARM PROC,EXC MAJ JT
225	1	FOOT PROCEDURES
226	1	SOFT TISSUE PROCEDURES
228	1	MAJOR THUMB OR JOINT PROC
229	1	OTHER HAND OR WRIST PROC, EX MAJ JT PROC
230	2	LOC EXCIS & REMOV OF DEVICE OF HIP & FEMUR
231	1	LOC EXCIS & REMOV OF DEVICE EX HIP & FEMUR
232	1	ARTHROSCOPY
233	1	OTHER MUSC SYS & CONN TISS O.R. PROC
235	2	FRACTURES OF FEMUR
236	2	FRACTURES OF HIP & PELVIS
237	1	SPRAINS & DISLOC OF HIP, PELVIS & THIGH
238	1	OSTEOMYELITIS
239	1	PATH FRACTURES & MUSC & CONN TISS MALIG
240	1	CONNECTIVE TISSUE DISORDERS
242	1	SEPTIC ARTHRITIS
243	1	MEDICAL BACK PROBLEMS
244	1	BONE DISEASES & SPECIFIC ARTHROPATHIES
246	1	NON-SPECIFIC ARTHROPATHIES
247	1	SIGNS & SYMPTOMS OF MUSC SYS & CONN TISSUE
248	1	TENDONITIS, MYOSITIS & BURSITIS

ADRG	PROF	DESCRIPTION
249	1	AFTERCARE, MUSC SYSTEM & CONNECTIVE TISSUE
250	1	FX, SPRN, STRN & DISL OF UPARM, HAND, FOOT
253	1	FX, SPRN, & DISL OF UPARM,LOWLEG EX FOOT
256	1	OTHER MUSC SYSTEM & CONNECTIVE TISSUE DIAG
257	2	TOTAL MASTECTOMY FOR MALIGNANCY
259	2	SUBTOTAL MASTECTOMY FOR MALIGNANCY
261	1	BREAST PROC, NON-MALIG EX BIOP & LOC EXCIS
262	1	BREAST BIOPSY & LOCAL EXCIS FOR NON-MALIG
263	2	SKIN GRAFT &/OR DBRID, SKN ULCR OR CELLU
265	2	SKIN GRAFT &/OR DBRID EX SKN ULCR OR CELLU
267	1	PERIANAL & PILONIDAL PROCEDURES
268	1	SKIN, SUBCUT TISSUE & BREAST PLASTIC PROC
269	1	OTHER SKIN, SUBCUT TISS & BREAST O.R. PROC
271	1	SKIN ULCERS
272	1	MAJOR SKIN DISORDERS
274	1	MALIGNANT BREAST DISORDERS
276	1	NON-MALIGANT BREAST DISORDERS
277	1	CELLULITIS
280	1	TRAUMA TO THE SKIN, SUBCUT TISS & BREAST
283	1	MINOR SKIN DISORDERS
285	2	AMPUT OF LOWER LIMB FOR ENDO,NUTR,& METAB
286	2	ADRENAL & PITUITARY PROCEDURES
287	1	SKN GFT & WND DBRID FOR ENDO, NUTR & METAB
288	2	O.R. PROCEDURES FOR OBESITY
289	2	PARATHYROID PROCEDURES
290	1	THYROID PROCEDURES
291	1	THYROGLOSSAL PROCEDURES
292	1	OTHER ENDOCRINE, NUTRIT & METAB O.R. PROC
294	1	DIABETES AGE > 35
295	1	DIABETES AGE 0-35
296	1	NUTRITIONAL & MISC METABOLIC DISORDERS
299	1	INBORN ERRORS OF METABOLISM
300	1	ENDOCRINE DISORDERS
302	2	KIDNEY TRANSPLANT
303	2	KIDNEY,URETER & MAJ BLADDER PROC FOR NEOPL
304	2	KIDNEY,URETER & MAJ BLAD PROC, NON-NEOPL
306	2	PROSTATECTOMY
308	1	MINOR BLADDER PROCEDURES
310	2	TRANSURETHRAL PROCEDURES
312	1	URETHRAL PROCEDURES
315	2	OTHER KIDNEY & URINARY TRACT O.R. PROC
316	1	RENAL FAILURE

ADRG	PROF	DESCRIPTION
317	1	ADMIT FOR RENAL DIALYSIS
318	1	KIDNEY & URINARY TRACT NEOPLASMS
320	1	KIDNEY & URINARY TRACT INFECTIONS
323	1	URINARY STONES W LITHOTRIPSY
324	1	URINARY STONES
325	1	KIDNEY & URINARY TRACT SIGNS & SYMPTOMS
328	1	URETHRAL STRICTURE
331	1	OTHER KIDNEY & URINARY TRACT DIAGNOSES
334	2	MAJOR MALE PELVIC PROCEDURES
336	2	TRANSURETHRAL PROSTATECTOMY
338	1	TESTES PROCEDURES, FOR MALIGNANCY
339	1	TESTES PROCEDURES, NON-MALIGNANCY
341	1	PENIS PROCEDURES
342	1	CIRCUMCISION
344	1	OTHER MALE REPROD SYS O.R. PROC FOR MALIG
345	1	OTHER MALE REPROD SYS O.R. PROC EX MALIG
346	1	MALIGNANCY, MALE REPRODUCTIVE SYSTEM
348	1	BENIGN PROSTATIC HYPERTROPHY
350	1	INFLAMMATION OF THE MALE REPRODUCTIVE SYS
351	1	STERILIZATION, MALE
352	1	OTHER MALE REPRODUCTIVE SYSTEM DIAGNOSES
353	2	PELVIC EVIS, RAD HYSTER & RAD VULVECTOMY
354	2	UTER,ADNEXA PROC FOR NON-OVAR/ADNEXA MALIG
356	2	FEMALE REPROD SYS RECONSTRUCTIVE PROC
357	2	UTER & ADNEXA PROC FOR OVAR/ADNEXAL MALIG
358	1	UTERINE & ADNEXA PROC FOR NON-MALIGNANCY
360	1	VAGINA, CERVIX & VULVA PROCEDURES
361	1	LAPAROSCOPY & INCIS TUBAL INTERRUPTION
362	1	ENDOSCOPIC TUBAL INTERRUPTION
363	1	D&C, CONIZATION & RADIO-IMPLANT, FOR MALIG
364	1	D&C, CONIZATION EXCEPT FOR MALIGNANCY
365	1	OTHER FEMALE REPRODUCTIVE SYSTEM O.R. PROC
366	1	MALIGNANCY, FEMALE REPRODUCTIVE SYSTEM
368	1	INFECTIONS, FEMALE REPRODUCTIVE SYSTEM
369	1	MENSTRUAL & OTHER FEMALE REPROD SYS DIAG
370	2	CESAREAN SECTION
372	2	VAGINAL DELIVERY W COMPLICATING DIAG
373	2	VAGINAL DELIVERY W/O COMPLICATING DIAG
374	2	VAGINAL DELIVERY W STERILIZATION &/OR D&C
375	2	VAGINAL DEL W OR PROC EXC STERIL &/OR D&C
376	1	POSTPART & POST ABORTION DIAG W/O OR PROC
377	1	POSTPART & POST ABORTION DIAG W OR PROC

ADRG	PROF	DESCRIPTION
378	2	ECTOPIC PREGNANCY
379	1	THREATENED ABORTION
380	1	ABORTION W/O D&C
381	1	ABORTION W D&C, ASPIR CURET OR HYSTEROTOMY
382	1	FALSE LABOR
383	1	OTHER ANTEPARTUM DIAG W MEDICAL COMPLIC
384	1	OTHER ANTEPARTUM DIAG W/O MEDICAL COMPLIC
386	2	BIRTH WEIGHT < 1000G
388	2	BIRTH WEIGHT 1000-2499G
391	2	BIRTH WEIGHT >= 2500G
392	2	SPLENECTOMY
394	1	OTHER O.R. PROCEDURES OF THE BLOOD
395	1	RED BLOOD CELL DISORDERS
397	1	COAGULATION DISORDERS
398	1	RETICULOENDOTHELIAL & IMMUNITY DISORDERS
400	2	LYMPHOMA & LEUKEMIA W MAJOR O.R. PROCEDURE
401	1	LYMPHOMA & NON-ACUTE LEUKE W OTH OR PROC
403	1	LYMPHOMA & NON-ACUTE LEUKEMIA
405	1	ACUTE LEUKEMIA W/O MAJOR O.R. PROCEDURE
406	2	MYEL DIS OR POOR DIFF NEOPL W MAJ OR PROC
408	1	MYEL DIS OR POOR DIFF NEOPL W OTH O.R.PROC
409	1	RADIOTHERAPY
410	1	CHEMOTHERAPY
411	1	HISTORY OF MALIGNANCY W/O ENDOSCOPY
412	1	HISTORY OF MALIGNANCY W ENDOSCOPY
413	1	OTHER MYEL DIS OR POORLY DIFF NEOPL DIAG
415	1	O.R. PROC FOR INFECTIOUS & PARASITIC DIS
416	2	SEPTICEMIA
418	1	POSTOPERATIVE & POST-TRAUMATIC INFECTIONS
419	1	FEVER OF UNKNOWN ORIGIN
421	1	VIRAL ILLNESS
423	1	OTHER INFECTIOUS & PARASITIC DISEASES DIAG
424	2	O.R. PROC W PRINCIPAL DIAG OF MENTAL ILL
425	1	ACUTE ADJ REA & DISTURB OF PSYCHOSOC DYSF
426	1	DEPRESSIVE NEUROSES
427	1	NEUROSES EXCEPT DEPRESSIVE
428	1	DISORDERS OF PERSONALITY & IMPULSE CONTROL
429	1	ORGANIC DISTURBANCES & MENTAL RETARDATION
430	1	PSYCHOSES
431	1	CHILDHOOD MENTAL DISORDERS
432	1	OTHER MENTAL DISORDER DIAGNOSES
433	1	ALCOHOL/DRUG ABUSE OR DEPENDENCE, LEFT AMA

ADRG	PROF	DESCRIPTION
434	1	ALC/DRUG ABUSE OR DEPEND OR OTH SYMPTOMS
436	1	ALC/DRUG DEPEND W REHAB
437	1	ALC/DRUG DEPEND, REHAB & DETOX
438	1	NO LONGER VALID
439	1	SKIN GRAFTS FOR INJURIES
440	1	WOUND DEBRIDEMENTS FOR INJURIES
441	1	HAND PROCEDURES FOR INJURIES
442	1	OTHER O.R. PROCEDURES FOR INJURIES
444	2	MULTIPLE TRAUMA
447	1	ALLERGIC REACTIONS
449	1	POISONING & TOXIC EFFECTS OF DRUGS
452	1	COMPLICATIONS OF TREATMENT
454	1	OTHER INJURY, POISONING & TOXIC EFF DIAG
456	1	BURNS, TRANSFERRED TO ANOTHER FACILITY
457	2	EXTENSIVE BURNS W/O O.R. PROCEDURE
458	1	NON-EXTENSIVE BURNS W SKIN GRAFT
459	1	NON-EXTENS BURNS W WOUND DBRID/OTH OR PROC
460	1	NON-EXTENSIVE BURNS W/O O.R. PROCEDURE
461	2	OR PROC W DIAG OF OTH CONTAC W HEALTH SERV
462	1	REHABILITATION
463	1	SIGNS & SYMPTOMS
465	1	AFTERCARE
467	1	OTHER FACTORS INFLUENCING HEALTH STATUS
468	2	EXTENSIVE UNRELATED O.R. PROCEDURE
469	1	PRINCIPAL DIAG INVALID AS DISCHARGE DIAG
470	1	UNGROUPABLE
471	2	BILAT OR MULT MAJ JT PROCS OF LOWER EXTREM
472	2	EXTENSIVE BURNS W O.R. PROCEDURE
474	2	RESPIRATORY SYS DIAG WITH TRACHEOSTOMY
475	2	RESPIRATORY SYS DIAG WITH VENT SUPPORT
476	2	PROSTATIC O.R. PROC UNREL
477	1	NON-EXTENS O.R. PROC UNREL

APPENDIX E
Stepwise Regression Output for Utilization (SUR) Model

* * * * M U L T I P L E   R E G R E S S I O N * * * *

Listwise Deletion of Missing Data

Equation Number 1   Dependent Variable..   SUR

Block Number 1. Method: Stepwise   Criteria PIN .4900
POUT .5100
AVGINC PABOR PPERLO TICAP PGRADE12 PGRAD9 UNRATE

Variable(s) Entered on Step Number
1.. PGRAD9

Multiple R	.78761
R Square	.62034
Adjusted R Square	.60452
Standard Error	26.26829

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	27058.43389	27058.43389
Residual	24	16560.54850	690.02285

F = 39.21382   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PGRAD9	9.190360	1.467618	.787614	6.262	.0000
(Constant)	77.593908	14.421306		5.381	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.430619	.415022	.352660	2.188	.0391
PABOR	.355812	.479220	.688696	2.619	.0154
PPERLO	-.410875	-.648997	.947252	-4.091	.0004
TICAP	.030436	.028762	.339051	.138	.8914
PGRADE12	.263275	.279463	.427787	1.396	.1761
UNRATE	-.334119	-.528231	.948952	-2.984	.0066

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1   Dependent Variable..   SUR

Variable(s) Entered on Step Number
2..   PPERLO

Multiple R	.88332
R Square	.78025
Adjusted R Square	.76114
Standard Error	20.41451

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	34033.67920	17016.83960
Residual	23	9585.30320	416.75231

F =   40.83202   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PPERLO	-2.610167	.638010	-.410875	-4.091	.0004
PGRAD9	10.291474	1.171892	.881980	8.782	.0000
(Constant)	110.541592	13.801035		8.010	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.272992	.333760	.328473	1.661	.1110
PABOR	.291417	.510320	.638400	2.783	.0108
TICAP	.327053	.377805	.277905	1.914	.0687
PGRADE12	-.195593	-.212945	.259813	-1.022	.3178
UNRATE	.006836	.008144	.311263	.038	.9699

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. SUR

Variable(s) Entered on Step Number
3.. PABOR

Multiple R	.91514
R Square	.83748
Adjusted R Square	.81532
Standard Error	17.95074

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	36529.94596	12176.64865
Residual	22	7089.03644	322.22893

F = 37.78881 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	3.766492	1.353237	.291417	2.783	.0108
PPERLO	-2.378688	.567141	-.374437	-4.194	.0004
PGRAD9	8.296567	1.255212	.711016	6.610	.0000
(Constant)	114.030830	12.200003		9.347	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.096409	.120595	.191955	.557	.5836
TICAP	.234300	.305473	.204955	1.470	.1564
PGRADE12	-.017568	-.020523	.166196	-.094	.9259
UNRATE	-.502391	-.518492	.173106	-2.779	.0113

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. SUR

Variable(s) Entered on Step Number
4.. UNRATE

Multiple R	.93871
R Square	.88117
Adjusted R Square	.85854
Standard Error	15.71057

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	38435.71786	9608.92946
Residual	21	5183.26454	246.82212

F = 38.93058 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	6.712501	1.589574	.519352	4.223	.0004
PPERLO	.419838	1.122805	.066088	.374	.7122
PGRAD9	6.956521	1.199758	.596174	5.798	.0000
UNRATE	-11.630327	4.185511	-.502391	-2.779	.0113
(Constant)	161.130134	20.032807		8.043	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.049724	.072264	.170849	.324	.7493
TICAP	.086037	.119709	.131457	.539	.5957
PGRADE12	.137367	.177938	.118191	.809	.4282

* * * * M U L T I P L E   R E G R E S S I O N * * * *

Equation Number 1   Dependent Variable..   SUR

Variable(s) Removed on Step Number
5..   PPERLO

Multiple R	.93828
R Square	.88038
Adjusted R Square	.86407
Standard Error	15.40037

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	38401.20830	12800.40277
Residual	22	5217.77409	237.17155

F =   53.97107   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	6.328201	1.188681	.489618	5.324	.0000
PGRAD9	7.167342	1.038115	.614242	6.904	.0000
UNRATE	-10.226519	1.813780	-.441751	-5.638	.0000
(Constant)	156.431964	15.294575		10.228	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.049870	.072236	.185633	.332	.7433
PPERLO	.066088	.081326	.173106	.374	.7122
TICAP	.088603	.144233	.254556	.668	.5114
PGRADE12	.059634	.095314	.255602	.439	.6653

End Block Number 1   PIN =   .490 Limits reached.

APPENDIX F
Stepwise Regression Output for Need (SNR) Model

* * * * M U L T I P L E R E G R E S S I O N * * * *

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. SNR

Block Number 1. Method: Stepwise Criteria PIN .4900
POUT .5100
AVGINC PABOR PPERLO TICAP PGRADE12 PGRAD9 UNRATE

Variable(s) Entered on Step Number
1.. PGRAD9

Multiple R	.74270
R Square	.55161
Adjusted R Square	.53293
Standard Error	3.63382

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	389.86281	389.86281
Residual	24	316.91190	13.20466

F = 29.52463 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PGRAD9	1.103156	.203023	.742703	5.434	.0000
(Constant)	48.770302	1.994971		24.447	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.118674	.105246	.352660	.508	.6166
PABOR	.346471	.429390	.688696	2.280	.0322
PPERLO	-.063653	-.092517	.947252	-.446	.6600
TICAP	-.055590	-.048339	.339051	-.232	.8185
PGRADE12	.127839	.124868	.427787	.604	.5520
UNRATE	.071448	.103941	.948952	.501	.6210

* * * * M U L T I P L E   R E G R E S S I O N * * * *

Equation Number 1   Dependent Variable..   SNR

Variable(s) Entered on Step Number
2..   PABOR

Multiple R	.79642
R Square	.63428
Adjusted R Square	.60248
Standard Error	3.35236

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	448.29363	224.14682
Residual	23	258.48108	11.23831

F =   19.94489   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	.570023	.249989	.346471	2.280	.0322
PGRAD9	.816025	.225693	.549391	3.616	.0015
(Constant)	49.740570	1.888998		26.332	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	-.157776	-.134879	.192258	-.638	.5298
PPERLO	-.020778	-.033078	.638400	-.155	.8781
TICAP	-.142301	-.135079	.263550	-.639	.5291
PGRADE12	.227935	.241245	.312223	1.166	.2561
UNRATE	-.005052	-.007862	.642838	-.037	.9709

* * * * M U L T I P L E   R E G R E S S I O N * * * *

Equation Number 1   Dependent Variable..   SNR

Variable(s) Entered on Step Number
3..   PGRADE12

Multiple R	.80967
R Square	.65557
Adjusted R Square	.60860
Standard Error	3.32646

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	463.33700	154.44567
Residual	22	243.43772	11.06535

F =   13.95759   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	.630831	.253481	.383431	2.489	.0209
PGRADE12	.234902	.201464	.227935	1.166	.2561
PGRAD9	.529294	.332607	.356349	1.591	.1258
(Constant)	45.679786	3.955100		11.550	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	-.101598	-.087387	.164994	-.402	.6917
PPERLO	.151181	.182477	.166196	.850	.4046
TICAP	.057686	.041293	.176491	.189	.8516
UNRATE	.097983	.135706	.255602	.628	.5370

*** * * * M U L T I P L E   R E G R E S S I O N * * * ***

Equation Number 1   Dependent Variable..   SNR

Variable(s) Entered on Step Number
4..   PPERLO

Multiple R	.81672
R Square	.66703
Adjusted R Square	.60361
Standard Error	3.34758

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	471.44291	117.86073
Residual	21	235.33181	11.20628

F =   10.51739   Signif F = .0001

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	.714690	.273484	.434403	2.613	.0162
PPERLO	.122253	.143744	.151181	.850	.4046
PGRADE12	.393609	.275547	.381933	1.428	.1679
PGRAD9	.262450	.458777	.176696	.572	.5734
(Constant)	41.465842	6.355409		6.524	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	.008956	.006739	.143698	.030	.9763
TICAP	.086874	.062862	.139969	.282	.7811
UNRATE	-.073077	-.049959	.118191	-.224	.8253

* * * * M U L T I P L E R E G R E S S I O N * * * *

Equation Number 1 Dependent Variable.. SNR

Variable(s) Removed on Step Number
5.. PGRAD9

Multiple R	.81354
R Square	.66185
Adjusted R Square	.61573
Standard Error	3.29600

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	467.77556	155.92519
Residual	22	238.99916	10.86360

F = 14.35300 Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
PABOR	.808603	.215361	.491485	3.755	.0011
PPERLO	.178490	.103258	.220725	1.729	.0979
PGRADE12	.529178	.138425	.513481	3.823	.0009
(Constant)	38.912828	4.455166		8.734	.0000

------------- Variables not in the Equation -------------

Variable	Beta In	Partial	Min Toler	T	Sig T
AVGINC	-.049017	-.039359	.218021	-.181	.8585
TICAP	.036398	.027115	.185804	.124	.9023
PGRAD9	.176696	.123873	.166196	.572	.5734
UNRATE	-.132422	-.101441	.198434	-.467	.6451

End Block Number 1 PIN = .490 Limits reached.