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THE UNIVERSITY OF ALBERTA

A DRG BASED HOSPITAL SERVICE POPULATION MODEL AND ITS APPLICATION IN ALBERTA

by

© Nora J. Fraser

A THESIS

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled A DRG Based Hospital Service Population Model and Its Application in Alberta submitted by Nora J. Fraser in partial fulfillment of the requirements for the degree of Master of Health Services Administration.

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ABSTRACT

In view of the substantial contribution of the hospital sector to health care costs and the emphasis on cost containment, a desire for the equitable allocation of resources warrants investigation of hospital resource consumption. Previous studies have examined the utilization of hospital resources; however, the focus has been on statistics such as the occupancy rate which does not accurately reflect resource consumption or facilitate resource allocation. Population based resource allocation and utilization measures, which may be attained by matching available resources with the population consuming the resources, are a means of achieving an equitable distribution of resources among acute care hospitals and geographic areas.

The service population model, as utilized in this study, was previously developed by Bay and Nestman (1980, 1984) and facilitates the derivation of population based measures. Earlier studies that have applied the service population model used traditional measures such as separations (SEP) and/or patient days (PDAY), both of which ignore the variations in resource requirement among disease categories. The purpose of this study was to review the allocation and utilization of hospital resources by Albertans during the 1984/85 fiscal year. The service population model was enlarged by incorporating a DRG (Diagnosis Related Group)-based utilization measure which accounted for, at least in part, resource requirement variation.

Major findings of this investigation include:

1. The average DRG (Diagnosis Related Group) weight (representing case mix complexity) of the Alberta data was 0.77 which was below the U.S.

theoretical average of 1.0. When those persons under 65 years of age were excluded from the analyses, the average DRG weight for Alberta increased to 1.03 indicating the more intensive nature of morbidity experienced by the older group.

2. Per case rates such as average DRG weight and average length of stay measures displayed a direct relationship with hospital size, level of care, and hospital location. The number of DRG-based weighted separations per capita declined as hospital size and level of care increased and for hospitals located in metropolitan areas. Regression analysis indicated that 10% of per case cost variation among Alberta hospitals was accounted for by case mix complexity.

3. High per capita utilization rates, such as the Bed Distribution Index and number of weighted separations per capita and low per case rates (average length of stay, average DRG weight) were associated with sparsely populated areas in Alberta whereas low per capita utilization rates and high per case rates were associated with urban areas. This phenomenon may have been attributed to a tighter bed supply and the availability of comprehensive delivery services.

4. The DRG-based utilization measure produced relevance and commitment indices that, in general, fell between the indices derived from the SEP and PDAY measures.

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CHAPTER I

INTRODUCTION

The increasing emphasis on cost containment coupled with the substantial contribution of the hospital sector to health care costs has stimulated the study of acute care hospital utilization patterns by health care providers, administrators, researchers, and policy decision makers. Owing to the strong effects of supply on the demand for health services and the free patient movement across hospital district boundaries, the use of utilization statistics such as occupancy rates as a basis for resource allocation seems inappropriate. Consequently, this study incorporated the service population model to derive population based utilization measures. The focus of this investigation was to review the allocation and utilization of health care resources by the Alberta population in the 1984/85 fiscal year.

1.1 Statement of the Problem

The traditional economic theory of supply and demand is not directly applicable in explaining a publicly funded health care system. The professionals operating within the system influence the demand for services as well as the provision of services. In addition, the financing of the health care system is such that (1) the consumer does not assume direct responsibility for costs and is often unaware of the magnitude of the costs; and (2) the government, in general, funds the system without direct control over the extent to which the system is used. Thus, there is concern about the equitable allocation of scarce resources.

Population based resource allocation and utilization measures can facilitate achieving an equitable distribution of resources among acute care hospitals and geographic areas. To apply these measures, the amount of resources that are available for allocation need to be matched with the population consuming these resources.

The service population of a particular district may be estimated by the census population but the service population of any one hospital is unknown because of unrestricted patient movement among districts and hospitals. Also a consequence of free patient movement is the difficulty in determining the number of persons being served by a hospital's resources or assigning these resources (e.g. beds) to a particular district. Thus, it is difficult to match the available resources with the service population.

Previous studies related to resource allocation have focused on utilization statistics. If one hospital generates more admissions or retains patients longer, the result will be an occupancy rate higher than another hospital operating on similar resources. (Often this is the case with volume-driven, cost based reimbursement systems). A hospital with a relatively high occupancy rate will appear more productive than others and thus, will likely receive more resources from the government than the hospitals with a lower occupancy rate despite the fact that that hospital may not serve a greater number of discrete patients. It is for these reasons that there is a need for a population based model which facilitates equitable resource allocation and alleviates some of the problems associated with the utilization approach.

1.2 Objectives of the Study

The primary purpose of this study was to explore the allocation and utilization of health care resources in Alberta for 1984/85 using the service population model. More specifically, the objectives were:

(1) To investigate the feasibility of developing population-based resource allocation and utilization measures.

(2) To derive population based resource allocation and utilization indices such as the BDI (Bed Distribution Index), the SPI (Service Population Index) and the USWERATE (weighted separations per capita) using the service population model and DRG data.

(3) To implement the model on a micro computer using an electronic spreadsheet software such as LOTUS 1-2-3.

1.3 Significance of the Study

The service population model has been incorporated in previous studies with either SEP (the number of separations) or PDAY (the number of patient days) being used as a proxy measure of resource use (Bay and Nestman, 1980, 1984). However, both these measures ignore the disparity in resource requirement for various disease categories; thus, medical input has been omitted. With the introduction of DRGs (Diagnosis Related Groups) and the availability of the U.S.

reimbursement schedule, it was possible to develop a DRG-based utilization measure. This not only has financial implications but, to a certain extent, the use of such a measure may influence the case mix composition of hospitals.

The thesis resulted in a model which could be very useful for hospital decision makers in comparing the performance of one hospital with that of others. In addition, it could provide valuable information for resource need assessment and allocation of resources for such agencies as the Provincial Government.

1.4 Assumptions and Limitations of the Study

The study methodology was based on the following assumptions:

1. The health care system in Alberta operates as a "closed" system. This assumption implies that the effects of non-residents seeking care in Alberta and the effects of Albertans obtaining hospital services outside the province can be ignored.

2. The province of Alberta can be divided into mutually exclusive and exhaustive geographic regions or service areas. The existing general hospital districts provided such a division.

The following limitations of the study were primarily data related or methodological in nature:

1. The data utilized in the research are retrospective in nature; thus, the data do not necessarily reflect current need or demand for hospital services but, alternatively, the utilization of services. Though prospective data would be desirable for planning and are more accurate measures of need and demand, the data are extremely costly to

obtain. In addition, the stochastic nature of health problems may compromise projections based on prospective data. It was believed that the advantages of utilizing available information outweighed the disadvantages and did not compromise the findings of the investigation.

2. Census data and Professional Activity Study (PAS) data are not directly comparable. The cross-sectional nature of census data which is collected at mid-year represents the average number of persons in an area for that year. Alternately, PAS data are collected continuously and consequently can not be regarded as an average.

3. Owing to underestimation, the true population may not be reflected in the census population as recorded by Statistics Canada. However, it was believed that every segment of the population had an equal chance of being underestimated and, therefore, systematic error was not likely.

1.5 Definition of Terms

ACUTE CARE HOSPITAL: "a (general) hospital which provides for the diagnosis and short-term treatment of patients for a wide range of diseases or injuries" (Alberta Hospitals and Medical Care, 1984/85, p.68).

AVERAGE LENGTH OF STAY: "the average number of days stay of in-patients who were separated from the facility during the reporting year. It is calculated by dividing the total days stay by the number of separations during the reporting year" (Alberta Hospitals and Medical Care, 1984/85, p.68).

DIAGNOSIS-RELATED GROUPS (DRGs): "...a manageable, medically interpretable set of case types that allows one to control for differences in complexity attributable to patient characteristics as described by age, primary diagnosis, secondary diagnosis, primary surgical procedure and secondary surgical procedure" (Fetter et al., 1980, p.21).

MAJOR DIAGNOSTIC CATEGORIES (MDCs): "The process of forming the DRGs was begun by partitioning the data base into mutually exclusive and exhaustive primary diagnostic areas, called Major Diagnostic Categories" (Fetter et al., 1980, p.6). Each MDC largely corresponds to an organ system.

PATIENT DAY (PDAY): "the day, or portion thereof, which an individual spends as an inpatient in a hospital, usually determined by his/her presence in a facility at 24:00 hours" (Toll, 1982, p.13).

PATIENT DESTINATION: the acute care hospital in which a patient obtains services.

PATIENT ORIGIN: the hospital district in which the patient maintains residence.

SEPARATION (SEP): the discharge, alive or dead, of an inpatient.

SERVICE POPULATION: "refers to the age-sex adjusted census population of a particular area. Provincial or hospital district service populations are equivalent to the age-sex adjusted census populations for the province or the hospital district respectively. However, the term is used somewhat differently when it is applied to a hospital service population. In this case, the service population is not associated with a specific geographic area but represents an age-sex adjusted 'population' or number of persons which could be described as potential users of the hospital under study" (Romeril, 1984, p.12).

DRG WEIGHT (DRGW): is a relative measure which represents the average resource requirement for cases in a particular DRG group relative to national average resources consumed by all U.S. separations.

UNITED STATES WEIGHT EQUIVALENT (USWE): the sum of separations weighted by the appropriate DRGW values. The average USWE (AUSWE) was calculated by dividing the USWE by total SEP and is an indicator of case-mix complexity. The average USWE was also referred to as the average DRG weight.

1.6 Format of Thesis

The thesis is presented in five sections. In the first part, the problem statement, objectives, significance of the study, assumptions and limitations, and definition of terms are discussed. Chapter II includes a selected review of the literature relevant to the thesis topic while Chapter III outlines the research strategies used to achieve the study objectives. Results are included in Chapter IV and the last section, Chapter V, contains conclusions and recommendations.

CHAPTER II

A SELECTIVE REVIEW OF THE LITERATURE

The purpose of the following literature review is to provide an overview of previous research developments and findings which have been reported and are of relevance to the objectives of this study. Four major components are included: (1) patient origin-destination methodologies; (2) classification systems in health care; (3) concepts related to health services utilization; and (4) the funding of health care in Alberta.

2.1 Patient Origin-Destination Patterns

Under the Canadian health care system, the traditional economic theory of supply and demand is not directly applicable for determining equitable resource allocation. "To achieve equitable allocation of resources among the communities within a hospital planning jurisdiction, it is necessary to match the amount of resources available with the population to be served" (Bay & Nestman, 1984, p.142).

Theoretically, this task appears to be elementary but from a practical viewpoint, matching available resources with the service population proves more difficult. A hospital's service population is not defined as it is not predetermined by geographic boundaries. Patient origin-destination methodologies have evolved to facilitate the estimation of service populations and service areas based on patient flow patterns.

In the development and application of a population-based resource allocation and utilization tool, the review of patient origin-destination studies is essential. The review is presented in three sections: 1) patient flow patterns; 2) delineation of service areas and service populations; and 3) resource utilization from both a community (origin) and a provider (destination) perspective.

2.1.1 Patient Flow Patterns

Concomitant with a complex urban society is the increasing cost of health care. Researchers in the health field have emphasized the need for rational planning of health care facilities and provision of services. To facilitate effective planning, one of the first considerations is to study the geographical areas in which patients reside as well as the hospitals in which they seek medical care. However, it is also necessary to examine the other side of the coin—the service area of and the resources provided by any one hospital to its service population (Drosness, Reed, & Lubin, 1965, p.34).

The study of patient care-seeking patterns is not a recent phenomenon. In 1942, Ciocco and Altenderfer, recognizing that political boundaries do not constitute barriers to movement by healthcare seeking individuals, studied the intercounty movement of the residents of eight states in the U.S. (Ciocco & Altenderfer, 1945). There were two main objectives: (1) to measure, in both quantity and direction, the movement of persons across county lines who were seeking obstetrical services and (2) to identify the counties which are "centers" for providing medical care and those counties which are dependent on these centers. The researchers developed two ratios to describe the pattern of flow from one county to another. While the in-residence (I.R.) birth ratio illustrated the number of births to residents occurring within the county relative to the total number of births occurring to residents, the out-residence (O.R.) birth ratio indicated the number of births to residents occurring outside the county relative to the total number of residential births. The findings showed considerable intercounty movement. In only thirty percent of the counties did ninety-five percent or more of the births to residents take place in the county of residence. As Ciocco and Altenderfer stated "these findings indicate how extensive is the movement across county boundaries for purposes of obtaining care for childbirth" (Ciocco & Altenderfer, 1945, p.976). The I.R. and O.R. ratios not only illustrated interdependence of counties but, in addition, the interdependence of counties could not be accounted for by political boundaries. It was further suggested by these authors that the concept of a medical trade area may more accurately describe, from a broad perspective, the movement of patients seeking health care while the use of ratios such as the I.R. and the O.R. allowed one to more specifically determine the pattern of flow for patients seeking obstetrical services (Ciocco & Altenderfer, 1945, p.984).

The physical distance to health care facilities is just one dimension to be considered when examining patient flow patterns (McGuirk & Porell, 1984) but has been the focus of several studies. Sharp and McCarthy (1971) used patient origin-destination data to examine patient flow patterns among 251 hospitals in Oregon, Washington and Idaho. They reported that it was the hospital closest to home to which most people went for medical care and that "hospital care is a local endeavor, for the most part" (Sharp & McCarthy, 1971, p.840). Distance was further investigated by Bashshur, Shannon, and Metzner who examined the ecological differences in the use of medical services (Bashshur, Shannon, & Metzner, 1971). The survey, conducted in the metropolitan area of Cleveland, showed a general inverse relationship between the distance to a hospital and the utilization of its services. They further stated that there was a limit to the distance people were willing or able to travel to secure services. Reviews by Shannon, Bashshur and Metzner (1969) and Studnicki (1975) revealed a long history of research investigation into the effect of distance on health care utilization. One of the significant conclusions arising from the literature was the positive impact that proximity had on the utilization of hospital services in rural areas where alternatives were not likely to exist or if they did, the distance was a prohibiting factor. The exception to this may be the utilization of specialized services where it has been reported that patients are willing to travel relatively further distances for special care (Morrill & Earickson, 1968; Cohen & Lee, 1985; Maher, 1987).

Marrinson (1964) believed that travel time rather than physical distance was a more appropriate factor in the determination of care-seeking patterns. The study, carried out in the Greater Cincinnatti area, used a time-circle concept. Owing to freeway expansion:

> the time circle study shows conclusively that many of the new outlying centers of the population are no farther removed in terms of travel time than were the older centers of population nearer to the central hospitals (Marrinson, 1964, p.54).

Other researchers corroborated that travel time was a more significant measure of accessability than physical distance (Drosness, Reed, & Lubin, 1965; Lubin, Drosness, & Wylie, 1965). McGuirk and Porell (1984) developed a spatial demand model to evaluate the impact of distance and time on hospital utilization and found that travel access "plays a significant role" (McGuirk & Porell, 1984, p.93) in the determination of utilization patterns in metropolitan areas where many alternatives exist. The researchers further noted that of particular interest was the sensitivity of patient trips to variations in travel time when distance was controlled (McGuirk & Porell, 1984). A more recent study done by Cohen and Lee (1985) in the state of Rhode Island, also substantiated the importance of travel time. The researchers reported that "travel time is a significant major deterrent to hospital utilization, whereas the size of a hospital is a major attraction" (Cohen & Lee, 1985, p.37). Bosanac, Parkinson, and Hall (1976) applied a thirty minute travel time standard when they reviewed the geographic accessability to hospital care of West Virginia residents. Their findings indicated that more than ten percent of this population lived in areas which were inaccessible, by this standard, to a general hospital. In addition, those out of reach of hospital care were considered to have sociodemographic characteristics associated with increased medical care needs (Bosanac, Parkinson, & Hall, 1976).

Some researchers have examined not only the effects of distance and time on utilization patterns but have also considered the role of various socioeconomic and demographic factors in patient origin-destination studies. Weiss and Greenlick (1970) researched the effects of social class and distance on contact with the medical care system in Portland, Oregon. They found that when middle and working classes were compared, distance and social class had an interactive relationship but the authors felt that social class was the more "powerful" variable. The researchers stated that "...distance affects the medical care process differentially by social class and interacts with social class as an explanatory variable" (Weiss & Greenlick, 1970, p. 462). Bashshur, Shannon, and Metzner (1971) while recognizing that distance was an important element in patient origin-destination methodology stated that

> ....patterns of discrimination, as well as status, related to ethnicity and occupation and involving the economics and sociology of reward distribution and the oddities of the medical care market, modulate distance and in instances determine it (Bashshur, Shannon, & Metzner, 1971, p.75).

Based in a southern rural community in the United States, Miners, Greene, Salber, and Scheffer (1978) examined the racial effect on patterns of utilization as well as monetary and nonmonetary determinants. They found that racial differences in the demand for health services did exist; however, travel time to the source of care was a more important determinant of demand than either price or income (p.274).

Other researchers have investigated what impact the health care facility and the physician have on patient flow patterns. Sharp and McCarthy (1971), in their patient origin study in Idaho and Washington, reported that "...patients prefer to be hospitalized near where they live, (and) that physicians prefer to treat patients in hospitals close to geographic locations of their professional practices..." (Sharp &

McCarthy, 1971, p.841). Morrill and Earickson (1968), examined the variation in the character and use of hospitals in the Chicago area and found that approximately two-thirds of the variation in pattern flows could be accounted for by the characteristics of the communities and the hospitals and the interaction between them (p.225). These authors also pointed out that hospitals were not homogeneous with respect to output. Those hospitals which provided special services in addition to the more common services attracted patients from further afield (p.225). Maher (1987) supported this statement when she concluded that patients seeking treatment for cardiovascular disease travelled further for the specialized care. Studnicki (1975) investigated travel time from a person's residence to his or her choice of facility and the variation in travel patterns owing to characteristics of both the patients and the hospitals. The results showed that distance was meaningless for twenty percent of the obstetrical patients in Baltimore City when other factors such as the physicians' location and referral practices and the payment status of the individual were considered (Studnicki, 1975, p.690).

Therefore, it is generally well established that travel costs measured by distance or time affect patient care-seeking patterns. However, the impact of socioeconomic and demographic characteristics of the service population cannot be ignored. Lastly, the heterogeneous nature of the health care facilities and the role of the physician are two other factors to be considered when conducting patient origin-destination studies.

2.1.2 Delineation of Service Areas and Service Populations

The terms service area or service population may also be referred to as the service "constituency". This latter expression denotes the importance of both the geographic location and demographic characteristics of the population (MacStravic, 1978, p.31). MacStravic goes on to define the service constituency as "...the set of people who are likely to have a need for a given service and have a significant probability of using a specific set of resources for that service" (MacStravic, 1978, p.32). For effective and sound planning to be facilitated, the identification and analysis of a hospital's service population is a principle requirement (Griffith, 1972, p.65).

Lembcke's study (1952) in which he attempted to measure the quality of medical care in terms of appendectomy rates was one of the earliest studies to incorporate the concept of the service area based on patient origin data. Lembcke was also one of the earliest researchers to recognize that residents of one region may travel to another region for hospital care. The hospital service areas were made to conform to township lines which outline the smallest geographic unit so that census data could be utilized. In Lembcke's conclusions, he reported the usefulness of using service areas for the purposes of comparing appendectomy rates and, subsequently, quality of care. However, he acknowledged the limitations of using this approach when a hospital service area was served by a number of hospitals (Lembcke, 1952, p.287) as was the case in some metropolitan areas.

Ten years later, in 1962, Poland and Lembcke used the equal-liklihood approach to further develop the concept of service area delineation. In a review of this procedure, Griffith (1972) pointed out that this approach was useful only in rural or near rural areas rather than urban settlements (p.68). The boundaries were determined at various points where the probability of a person seeking health care from one hospital is equal to the probability of that person obtaining service from another health facility. "A service area must have one continuous line for its boundary. That is, service area boundaries cannot cross each other or include more than one enclosed area" (Griffith, 1972, p.70). After patient flow data were analyzed, the researchers further reported that those hospitals with specialty services tended to draw persons from a greater distance; similarly, those people with relatively complex diseases traveled further to a hospital than those without.

A mathematical gravity model was developed by Meade (1974) for delineating hospital service areas. The model was based on the premise that "...a place will attract trade from an individual in its adjacent area in direct proportion to the size of the service center and in inverse proportion to the square of the distance away from the service center" (Meade, 1974, p.357). The size of the service center (hospital) was determined by the number of beds, the facilities offered, and the number of physicians working within it. As the quantity of these three factors grew, so would the drawing power of the hospital. To test the model, Meade compared the map of the patient origin pattern based on patient origin data with the patient origin map derived from the gravity model. He found that the two maps were similar with respect to hospital service areas and concluded that the gravity model would provide economic as well as logistic advantages for further studies (Meade, 1974, p.364).

While the application of patient origin-destination methodologies have successfully delineated service areas in sparsely populated regions, the application is more complex when metropolitan areas are considered. "Urban communities contain multiple hospitals which vary in size and specialization; the communities are also interspersed with a dense, heterogeneous population distribution" (Maher, 1987, p.90). Drosness, Reed, and Lubin (1965) attempted to resolve some of the problems endemic to the urban setting by using computer graphic techniques to delineate service areas in California. This approach was based on the number of admissions each census tract contributed to the total admissions of a given hospital. Even with this technique, however, it was noted that patient flow patterns involved considerable boundary crossing. Morrill and Earickson (1968) investigated the variation in the character and use of Chicago area hospitals and also noted the boundary crossing behavior as did Drossness, Reed, and Lubin (1965). Further, they stated that variables such as volume and scope of services as well as location of the hospital could account for much of the behavior variation. In a later paper by Zimmerman (1975), the difficulties in delineating service areas in urban populations were summed up:

> In the current pluralistic health system, consumers tend to be mobile, eclectic in their health care habits, and unable or unwilling to establish a permanent relationship with one family physician or health institution (Zimmerman, 1975, p.46).

Griffith (1972) recognized that previous approaches used in determining service areas (e.g. equal-liklihood approach) were based on a dichotomous decision - in or out of the service area and that the reality was a more "fluid" phenomenon involving a "continually decreasing tendency to use a given hospital as the distance from it grows". (Griffith, 1972, p.74). Hence, he proposed to use two indices- the relevance index and the commitment index - which algebraically defined the tendency of each geographic area to use a specific study hospital and, hence, defined the service population of a hospital. In addition, characteristics of specific hospitals were revealed which enabled effective planning of health care resources. The Relevance Index (RI) reflected the market share of a hospital in a certain district and was defined as the proportion of total admissions from a specific geographic location which used a particular hospital (Griffith, 1972, p.76). The total service population of any one study hospital was estimated by multiplying the population of a geographic area by its respective RI and then summing over all areas. The Commitment Index (CI) was algebraically defined as the proportion of total admissions to the study hospital which originated from a particular geographic area (Griffith, 1972, p.76). The CI can also be described as the amount of resources from any one hospital that were allocated or consumed by residents of some geographic district. These two indices were summarized by Zimmerman (1975):

> The index of relevance refers to the extent to which the population of a given geographic area uses the hospital; the index of commitment refers to the proportion of the hospital's resources committed to serving that population or area (Zimmerman, 1975, p.47).

Utilizing the concepts put forth by Griffith (1972), Zuckerman (1977) undertook a patient origin study which involved eighty-eight acute care hospitals in Pennsylvania. He analyzed community-to-hospital flow patterns for inpatient services, outpatient clinics, and emergency services. Using patient origin-destination data from 1965 and 1974, hospitals were grouped according to the residences of patients using the facilities and communities were grouped according to the similarity of patterns in hospital use of the region (Zuckerman, 1977, p.85). A utilization matrix was then developed with the relevance and commitment indices for the two years enabling the researcher to report any significant changes as well as facilitating subarea and areawide hospital planning.

Bay and Nestman (1980) refined and generalized the concept of hospital service populations and the estimation techniques previously proposed by Griffith. In a study done involving the general hospitals of Alberta, Bay and Nestman were able to show:

> (1) "The service population of a hospital should and can be defined without direct association with a geographic area" (p.680); (2) the RI and CI could be calculated using other utilization measures than admissions such as patient days or discharges (p.680); (3) the service population concept may be useful from a broader perspective of province or state rather than the more narrow focus of single hospital (p.681).

The researchers also carefully examined assumptions of homogeneity with regard to physician practice and referral and hospital specialization. In their conclusion, they exercised caution when it was stated that consumption of resources or allocation rates varied more among hospitals than districts, and the authors emphasized various deficiencies and weaknesses in the model (p.694).

Carpenter and Plessas (1985) reported a slightly different methodology for estimating hospital service areas in Detroit which utilized mortality statistics as a proxy measure for discharges. When the RI and CI were computed, both deaths and discharges were utilized in the formulas so that comparisons could be made between the two techniques. Carpenter and Plessas noted the limitations involved in the methodology when they concluded that

> ...adequate predictions of overall patient flows can be made from death indexes although, for hospitals viewed individually, their market share of small geographic areas will not be reliably and consistently predicted from death indexes. Nevertheless, the overall shape and boundaries of the total service area can be predicted (Carpenter & Plessas, 1985, p.25).

2.1.3 Resource Utilization

If health planners are to achieve equitable distribution of resources, then a logical prerequisite would be to match the amount of available resources with the service population (Bay & Nestman, 1984, p.142). This implies that researchers and planners should measure the distribution of resources on a **per** capita basis. However, owing to a variety of factors such as inadequate data, political barriers, and methodological issues in computing per capita measures when patients seek care outside jurisdictional boundaries, inappropriate utilization measures such as occupancy rates were previously involved in planning activities (Shaughnessy, 1982; Bay and Nestman, 1984). The emphasis has now been placed on developing population based methodologies that measure the allocation and utilization of health care resources on a per capita basis.

Shaughnessy (1982) outlined two methods for computing per capita measures - the community-based (CB) method and the provider-based (PB) method. The CB measures can be referred to as population based per capita measures as they "...pertain to the consumption of health care services for a specific population or population group" (Shaughnessy, 1982, p.64). To compute these measures, service utilization by the residents of a geographic area were summed over all providers, regardless of where service occurred. The resulting total utilization of health services by a community was then divided by the population of the community. PB measures, on the other hand, "...correspond to a provider group which is allocated portions of populations...to determine the number of people served by the provider group" (Shaughnessy, 1982, p.64) and therefore, should not be referred to as population based measures as they do not pertain to a single population group. Once the population size was determined by the PB method, it acted as the denominator for per capita measures while the numerator reflected the total resources (e.g. beds) used by the provider. Shaughnessy noted that these two methods warrent individual interpretations; however, he later pointed out that often it was useful to anlayze PB and CB measures in conjunction with one another because PB measures "...reflect provider performance in the same per capita units as those employed to reflect the consumption of health services by residents of a particular community" (p.63).

The community-based approach was used by Wennberg and Gittelsohn (1973) when they examined the extent to which beds, manpower, expenditures and utilization measures varied among thirteen hospital service areas in Vermont. In using population based per capita utilization measures, the researchers reported wide variations in all of the aforementioned factors among neighboring communities. Again, this approach was used in a later study done by Wennberg and Gittelsohn (1982) in which they investigated surgical rates among small service areas in the six states of New England. They found substantial variation in rates among the states as well as variation in overall expenditures for other medical treatments (p.120).

Most studies utilized the CB approach which enabled researchers to analyze potential variations in utilization measures among communities; there were few studies which incorporated the PB method. However, Griffith (1978) used this latter approach to define several per capita measures of hospital performance related to quality, quantity, and cost of services. The hospital performance indicators were later used in a study to examine hospital services in Michigan (Griffith, Restuccia, Tedischi, Wilson, and Zuckerman, 1981). Some of the findings reported were that population size was an important predictor of hospital use while region was a poor predictor; and age adjustment was a necessity if worthwhile comparisons were to be made. Griffith acknowledged the measurement problems inherent in "quality of care" analyses owing to its "soft" nature. In addition, he expressed concern with the lack of case mix recognition in the indicators.

Both the CB and PB methods were incorporated in a study done by Bay and Nestman (1984) in which two indices were developed to measure the distribution of hospital beds in each district and the service population of each hospital. The two indices, the BDI (Bed Distribution

Index) and the SPI (Service Population Index), enabled the researchers to identify under-or-overbedded districts and under-or-overloaded hospitals. The BDI was defined "...as the number of beds per 1,000 age-sex adjusted residents and is specific to hospital district" (Bay and Nestman, 1984, p.146) while the SPI was defined "...as the number of persons served by each hospital bed" (p.146). In concurrence with Shaughnessy (1982), Bay and Nestman noted that it was advantageous to examine both indexes simultaneously so as to provide an accurate picture of the available resources and the population being served.

2.1.4 Summary

From the review, it is evident that patient origin-destination studies have been the cornerstone upon which much hospital planning has been based. Patient care-seeking patterns have been related to a number of factors. Distance, and then later, time were shown to have a significant impact on behavior and were two variables upon which many researchers focused in their attempt to describe and forecast flow patterns. Later studies, however, revealed numerous other characteristics such as those of the hospital, the physician, and the service population itself which influenced patient care-seeking behavior in some way.

Patient origin-destination methodologies have also assisted in the delineation of service areas and service populations. Recognizing that political boundaries were inappropriate for the above task owing to free patient movement among districts, researchers have developed two indices, the RI and CI, to assess the relationship between certain hospitals and districts.

Finally, patient origin-destination studies have been used to calculate per capita utilization measures from a CB and PB perspective. While the CB method provides useful information regarding per capita resource utilization, the PB method relates to per capita resource allocation. When both methods are employed, researchers have noted their usefulness in facilitating health care planning.

2.2 Classification Methodologies

In order to extract useful information from voluminous amounts of data, a data reduction technique which groups these data into meaningful classes or groups of information is valuable. One such reduction technique that has been applied in many areas of the health care system is that of classification systems. In the following sections, three classification systems will be described: (a) disease classification; (b) patient classification; and (c) hospital classification.

2.2.1 Disease Classification

Disease classification is the first classification system developed and used in the health care field. The first formal system, constructed in 1883, was etiologically based and categorized causes of death in order to ascertain the effects of public disease control programs (WHO, 1977, p.xiii). The increasing interest in morbidity studies and the need for comparability of classification by various health agencies stimulated the expansion, in 1948, of the original classification system to include both mortality and morbidity statistics. This system was referred to as the International Classification of Diseases (ICD) and is revised approximately every ten years by the World Health Organization (WHO) with the assistance of several national committees (Lilienfeld & Lilienfeld, 1980, p.67).

The ICD classification system has been modified several times in an effort to provide North American hospitals with a system that is both more efficient and more effective. Experimentation with the ICD for indexing medical records began in 1950 within numerous American hospitals and in 1954, hospitals using Professional Activity Study (PAS) began using the ICD with its various modifications from previous experimentation. The product of this undertaking was the publication of ICDA (International Classification of Diseases, Adapted for Indexing Hospital Records) in late 1959. The ICDA which involved standard modifications for disease classification and accompanying operation codes was introduced into PAS hospitals directly after publication and spread rapidly during the mid-sixties throughout hospitals in the US and Canada (Commission on Professional and Hospital Activities (CPHA), 1970, pp. xi-xiii).

In 1967, the eighth revision of ICD (ICD-8) was published by the WHO. This revised version was quickly adapted in 1968 by the U.S. Public Health Service and ICDA-1693 (Eighth Revision International Classification of Diseases, Adapted for Use in the United States) was the result. Although the ICDA-1693 was considered to be an improvement over its predecessor in some respects, it overlooked the needs of morbidity classification and it was felt by some that the ICDA-1693 should be modified for more effective use in hospitals. In order to avoid issuing a list of changes, additions, and deletions a complete adaptation was published in 1969 entitled the Hospital Adaptation of ICDA (H-ICDA). The H-ICDA incorporated changes in the sections on mental disorders, causes of perinatal morbidity, and external cause of injury. In addition, H-ICDA was based on body systems rather than surgical specialties as before (CPHA, 1970, pp. xiii-xiv).

The swift advancements in medical knowledge and the need to classify data at various levels of care sparked the introduction of the second edition of H-ICDA (H-ICDA-2) in 1974. In an attempt to maintain comparability between the old and new classifications while at the same time introducing changes that would reflect the current concepts in medicine, the revision included: (1) some expansion at the fourth-digit level to increase detail; (2) some compression at the fourth-digit level where experience had shown the detail to be unused; (3) creation of three-digit categories to identify conditions not distinguished in the previous classification; (4) the expansion of the chapter dealing with signs and symptoms to facilitate recording practices in primary-care and outpatient encounters; (5) expansion of the supplementary classification (Y codes) to accomodate descriptions of reasons other than diagnoses or traditional symptoms for which the patient enters the health care system; and (6) complete revision of the surgical classification (CPHA, 1973, pp. vii-viii).

A ninth revision of the ICD (ICD-9) was later developed. In February of 1977, the National Center for Health Statistics convened a steering committee for the purpose of developing a clinical modification of the ICD-9. Thus, becoming effective in January, 1979, the ICD-9-CM provided a single classification supplanting all previous classification schemes. The ICD-9-CM is compatible with the ICD-9 and yet it provides greater specificity at the fifth-digit level of detail as well as including health-related conditions (CPHA, 1980, pp.iii,xxi-xxiv).

Canadian provinces also use an abridged version of the current ICD system (ICD-9) which is provided by Statistics Canada and is entitled the Canadian Diagnostic Code (CDC). This code was modified in 1979 and is referred to now as the Canadian Diagnostic List (CDL). Statistics Canada developed this list in an effort to reflect Canadian patterns of morbidity and mortality. Further, the ICD-9-CM classification system is used by all acute care hospitals in Alberta for tabulating morbidity and mortality data (Romeril, 1984; Maher, 1987).

The disease classifications previously discussed are etiologically-based and some researchers believe that these systems are not appropriate for the analysis of medical care utilization (Hurtado & Greenlick, 1971). Hurtado and Greenlick described a disease classification system which was developed for a utilization study of the Kaiser Foundation Hospitals in Portland, Oregon. The Kaiser Clinical Behavioral Classification System was based on the hypothesis that "...different sets of background characteristics are significant determinants of medical care utilization in different disease situations..." (Hurtado & Greenlick, 1971, p.236). Using the ICDA as the basic morbidity coding system, the researchers grouped the conditions listed in the ICDA into ten behavioral classes, each representing a "...similar medical care utilization response among persons of similar background characteristics..." (p.237). The purpose of this classification system was to assess the amount of health care resources required for treatment of the ill by tabulating these services according to this classification system.

2.2.2 Patient Classification

When a patient classification system is used, a comprehensive range of health related problems are assessed before making a classification decision rather than only a few etiological factors as is the case in the disease classification system.

There are essentially two methods of patient classification systems - classification by types of care and classification by levels of care. Bay, Leatt, and Stinson (1982) stated that not only do these two methods differ in their purpose but that the methods differ with respect to the composition of the target population and they operate at different levels in the health care system (p.471).

Classification by types of care refers to the categorization of patients according to their needs in terms of medical and social services required (National Health and Welfare, 1973) and was originally introduced by a Canadian Federal Working Party Report. Classification by types of care facilitates the selection of the most appropriate type of care and program or facility for the patient after a comprehensive assessment has been made. There are five types of care: Type I - stable disability or disease requiring minimal assistance in terms of special equipment or nursing service and which usually can be provided by non-institutional programs; Type II - characterizes a patient with a chronic illness who has little need for diagnostic or therapeutic services. In

Alberta, this type of care is usually provided in nursing homes; Type III - a chronically ill patient who may or may not be stabilized and requires therapeutic services on a 24 hour basis. Auxiliary hospitals usually provide this type of care; Type IV - refers to those with a functional disability who have the potential for rehabilitation; and Type V - a patient suffering from serious illness and requires acute care of relatively short duration.

With respect to classification by levels of care, patients are classified according to the amount of direct nursing care needed. The "critical indicators of care" are used to classify the patient into the most appropriate level of care of which there are usually three, four or five ranging from minimal care to intense care depending upon the specificity required (Giovannetti, 1978, p.4). The application of classifying patients by levels of care is most often seen in medical-surgical units in an attempt to derive the number of direct nursing care hours required by the patient. However, research into classification by levels of care has reached into other areas of the health care field. In a monograph (1978), Giovannetti outlined various health units (pediatric, psychiatric) in which this type of classification system may be used. Further, Chagnon, Audette, and Tilquin developed a special patient classification system for pediatric patients in the Hopital Sainte-Justine (1977).

There are several inherent limitations with patient classification systems. The concepts of types and levels of care are clearly distinct; however, often the terminology is lacking in clear delineation and universal acceptance (Bay, Nace, Leatt, & Stinson, 1982, p.471). It is noted by researchers that both methods of classification "...have been criticized for their lack of precise definitions of categories and lack of mutual exclusiveness of categories" (Bay, Leatt, and Stinson, 1982, p.471). Lastly, the reliability and validity of patient classification systems have not been adequately demonstrated before implementation, resulting in much criticism.

The inadequacy of using patient classification systems to compare resource allocation and use among health care facilities is obvious. This classification methodology was not developed for this purpose. Thus, hospital classification systems were developed and applied in an effort to facilitate comparisons of resource use and to promote equitable resource allocation decisions.

2.2.3 Hospital Classification

A classification scheme allows for the grouping of items which, in turn, facilitates the reduction of a large population into smaller segmented portions (Plomann, 1985). Donabedian (1973) pointed out that hospitals may be classified according to a multitude of characteristics and that "...many of these characteristics have important implications for the nature and quality of the hospital product and are therefore important considerations in the assessment of the hospital establishment" (Donabedian, 1973, p. 242). There is a dependency, therefore, upon the measures of hospital productivity and the definition of the hospital output for the classification of hospitals.

Traditionally, the process-oriented perspective has been used to define the hospital output. Inputs (services) were related to outputs (patient-days, number of admissions) (Tatchell, 1983). However, this orientation had its weaknesses - differences between "similar" hospitals were not adequately explained and hospital services bore little relationship with the outcome or health status of the individual patient (Fetter et al., 1980; Tatchell, 1983): "The relative proportions of the different types of cases the hospital treats are collectively referred to as its case mix" (Fetter et al., 1980, p.1) and it is this variable that was found to be significant in the measurement of output.

There are two general approaches used to measure a hospital's case mix - the indirect and the direct approach. The indirect approach uses proxy measures such as hospital size as measured by the number of beds or service mix to define the hospital output while the direct approach utilizes diagnostic data to categorize similar groups of patients (Watts & Klastorin, 1980; Williams, Kominski, Dowd, & Soper, 1984). The following sections review the literature related to these two approaches.

2.2.3.1 Indirect Case Mix Measurement

A number of indirect approaches to measuring case mix evolved during the 1960's and 1970's. In an early study, Feldstein (1961) used the number of patient days as a surrogate measure of hospital output while Carr and Feldstein (1967) attempted to account for output differences by using the number of services offered by hospitals. In a later study by Feldstein in 1968, a slightly different perspective was taken. In his study of 177 British hospitals, the proportion of a hospital's patients in each of eight clinical services was used to describe case mix differences. It was found that specialty differences "...could account for 25 percent of the variation in per-case costs across the hospitals (Bentley & Butler, 1982).

Based on the availability of specific facilities and services and by means of an algorithm, Berry (1973) grouped hospitals into one of four types: (1) basic service hospitals; (2) quality-enhancing hospitals; (3) complex service hospitals; and (4) community service hospitals. In his conclusion, Berry noted that the services provided in this hospital typology ranged from the most basic services provided in a small institution through to the more complex services provided by the hospital that served as a community medical center as well as an inpatient facility. He further concluded that there was a definite relationship between the availability of facilities and services and the capacity of hospitals to provide specific services and a relationship between the provision of services and hospital costs (Berry, 1973, p. 12). In an effort to replicate Berry's results, Klastorin and Watts (1982) used 1978 data from the American Hospital Association to investigate whether or not hospitals' facilities and services exist in some well-defined order. Although they found that an order did exist, and was relatively stable, their data did not support Berry's finding that there existed distinct groups but that hospitals were more differentiated now than at the time of Berry's study (Klastorin & Watts, 1982, p. 449).

Cluster analysis is one technique used by researchers to classify hospitals. Phillip and Iyer (1975) used cluster analysis to classify all community hospitals operating in the United States. In their study, two sets of variables were considered: (1) product characteristics-variables used as proxy measures for product mix and (2) external characteristics - proxies for external socioeconomic, demographic, and related characteristics over which the hospital had no control. The researchers acknowledged that it was not a definitive classification and that it should "...be used as a basis for making tentative identifications of hospitals whose operations call for closer scrutiny" (Phillip and Iyer, 1975, p. 366). Trivedi (1978) also used cluster analysis to classify 94 short-term general hospitals. The analysis resulted in five clusters with Group 1 representing small hospitals in rural areas (mostly primary care hospitals) and Group 5 representing large, metropolitan tertiary care hospitals.

Neumann (1980) proposed a modified approach to classifying hospitals in an effort to circumvent the subjectivity used to select classification criteria in Trivedi's and other similar hospital models. Neumann adopted a statistical model to select, initially, the characteristics by which community hospitals could be classified. Trivedi (1979) criticized the methodology used in Neumann's research, pointing out Neumann's unwavering dependence on statistical validation and his rejection of subjective decisions as well as various inconsistant assumptions. Klastorin and Watts (1981) applied cluster analysis to a data set of 200 short-term general hospitals and demonstrated the potential effects of various constraints (which could be used to reduce subjectivity) on the hospital classification process. These authors concurred with Trivedi that "No statistical methodology can, or should, totally remove the subjective element from decisions that, by definition, involve value judgements" (Klastorin & Watts, 1981, p. 216).

Alpander (1982) hypothesized that the "degree of structural differences among hospitals is related to their degree of internal complexity" (Alpander, 1982, p.9) and developed a typology of hospitals based on their internal complexity characteristics. Using the variables size, technology, patient turnover, and bureaucracy to compute the complexity, Alpander defined seven types of hospitals which ranged from low complexity, (e.g. small community hospital) to high complexity (e.g. very large hospital with specialty services).

Some researchers attempted to use relatively more direct measures of case-mix to classify hospitals. Lave and Lave (1971) studied the case-mix of 64 western Pennsylvania hospitals comparing the hospital characteristics and diagnostic output measures. They concluded that there was more variation in case mix across hospitals at any one point in time than within any hospital over a short period of time. They further concluded that hospital characteristics such as size, teaching status, and number of advanced services could not be considered good surrogates for case mix because they explained less than an optimal amount of variation in the case mix measures (Lave and Lave, 1971, p. 37-8). Using a similar approach, Evans (1971) conducted a study in Ontario using 185 acute-care hospitals. Ontario hospitals were differentiated according to the proportion of total patient-days within each of 41 broad ICDA diagnostic categories, age, sex, bed size, and the case-flow rate. Evans demonstrated through regression analysis that diagnostic mix had a significant impact on hospital costs. Further research by Evans and Walker (1972) supported the results reported earlier by Evans. Evans and Walker (1972) studied 90 hospitals in British Columbia and used information theory to adjust for case mix differences. Though they did not develop hospital classifications per se, Evans (1971) and Evans and Walker (1972) demonstrated the significant influence of diagnostic mix on hospital costs over surrogate case mix measures such as hospital size as measured by the number of beds.

2.2.3.2 Direct Case Mix Measurement

Although some of the studies reviewed in the previous section incorporated diagnostic groupings, the categories were defined in terms of medical specialties or broad ICDA groups. The direct case mix approach relies on the readily available, large sets of patient-specific data that amalgamate exact diagnostic categories with information on cost or length of stay (Williams et al., 1984).

> It was proposed that this approach to hospital classification would permit the direct comparison of individual case costs and lengths of stay among hospitls, and facilitate intra-hospital analysis regarding the reasons for differential costs or lengths of stay for case types (Maher, 1987, p. 67).

ICD-9-CM List A.

The Professional Activity Study (PAS) List A, developed by the Commission on Professional and Hospital Activities (CPHA), was one of the earliest attempts to group patients using diagnostic information. It was designed to assist in the review and evaluation of care for inpatients. The list was based on 350 diagnostic categories. However, when publishing length of stay and charge data, PAS generally added five age variables in addition to dichotomies for operated/not operated and single diagnosis/multiple diagnosis resulting in anywhere from 3,500 to 7,000 cells. While useful for some purposes such as length of stay comparisons between peer hospitals, the large number of classes inhibited the utility of statistical analyses and at the same time provided an incentive to develop alternative case mix measures (Ament, Dreachslin, Kobrinski, & Wood, 1982; Bentley & Butler, 1982).

Development of the DRG Classification System

As an alternative classification system, DRGs were developed by a group at Yale University in the late 1960's and early 1970's. The motivation behind the development of this classification methodology lay in the desire to provide an effective framework within which the utilization review function could be performed; initial intentions were not for the DRG system to be utilized as a reimbursement tool (Bentley & Butler, 1982; Fetter et al., 1980; Johnson & Appel 1984). The fundamental purpose of the DRG classification methodology was "...to identify in the hospital acute-care setting a set of case types, each representing a class of patients with similar processes of care and a predictable package of services (or product) from an institution" (Fetter et al., 1980, p.3). To achieve that objective, the developers felt that the following attributes were necessary: (1) medically interpretable with subclasses of patients from homogeneous diagnostic categories; (2) classes should be defined on variables which are commonly available on discharge abstracts; (3) a manageable number of mutually exclusive and exhaustive classes; (4) classes should be made up of patients with similar measures of expected measures of output utilization; and (5) class definitions must be comparable across different coding schemes (Fetter et al., 1980, p. 5).

The first step was to partition the data base which consisted of hundreds of diagnostic codes into 83 mutually exclusive and exhaustive primary diagnostic groups called Major Diagnostic Categories (MDCs). These groups were specified based on clinical judgements about the patients' medical conditions and the following 3 general principles:

1. Major Diagnostic Categories must have consistency in terms of their anatomic, physiopathologic classification, or in the manner in which they are clinically managed.

2. Major Diagnostic Categories must have a sufficient number of patients.

3. Major Diagnostic Categories must cover the complete range of codes without overlap (Fetter et al., 1980, p. 6).

Before further partitions were made, each MDC was refined by (a) excluding cases with dead patients; (b) eliminating records with obvious coding errors; and (c) eliminating observations with unusually high values of length of stay. The second step entailed using a statistical algorithm (CLASSIFY) to produce subgroups which might differ with respect to length of stay. The data base consisted of 700,000 discharge abstracts from hospitals in New Jersey, Yale-New Haven, and South Carolina.

Variables yielding the highest reduction in length of stay variance were used to partition the remaining cases in the data set. The independent variables selected as input to the algorithm were intentionally chosen for their direct influence on the patients' length of stay and they included diagnoses, surgical procedures, age, sex, and clinical service. When the partioning was complete, "The decision to accept, to reject or possibly to revise the recommended partioning, was based on both the statistical evidence and the clinicians medical knowledge" (Fetter et al., 1980, p. 12). Once each MDC was initially partioned into subgroups (based on the independent variables), a decision was made to either continue subdividing or treat the group as a terminal point. Partioning ceased for any given group when either the number of observations in the group was less than 100 or the unexplained variation could not be reduced by at least 1 percent by any of the variables (Fetter et al., 1980, p. 13). In some cases, the process was halted for nonstatistical reasons such as overall manageability or medical interpretability. The iterative process resulted in the formation of 383 DRGs with classes that were clinically consistent and were characterized by similar patterns of output utilization as measured by length of stay (Fetter et al., 1980, p. 38).

With the adoption in 1979 of the ICD-9-CM disease classification system, the second generation of DRGs was formulated. The experience gained through use of the original DRG system suggested that some problems could be eliminated or reduced during the reformation. The ICD-9-CM DRG classification scheme was developed using similar techniques as those used in the construction of the original DRG system. However, there were several important differences between first and second generation DRG systems (Williams et al., 1984, p. 19; Health Systems International, 1983).

The new system was based on a sample from a much larger population than the original DRG classification system (Williams et al., 1984). Approximately 1.4 million discharge abstracts were obtained from a stratified national sample of United States hospitals subscribing to CPHA, with length of stay as the measure of hospital resources. Of the 1.4 million abstracts, 394,814 records were used to develop the system while the remaining data records were used for purposes of verification (Plomann, 1982).

A panel of physicians assigned all of the possible principle diagnoses into 1 of 23 mutually exclusive Major Diagnostic Categories. Clinical judgements were given greater priority in the new DRG system and the decisions were well documented (Williams et al., 1984; Coffey and Goldfarb, 1986). Generally, each MDC corresponded to an organ system. In addition, prior to partioning the MDCs according to the variable which caused the greatest reduction in length-of-stay variance, most were dichotomized into medical and surgical groups. This action was based on the premise that surgical procedures requiring operating room privileges would also have an impact on the amount of hospital resources used.

Disaggregation of each MDC was performed primarily on the basis of clinical judgement and secondly on the basis of five variables (principle diagnosis, type of surgery, presence of specific complications or comorbidities, age, and patient's discharge status). With few exceptions, a potential subcategory did not become a DRG unless the following three criteria were satisfied: (1) the subcategory was believed by the panel to be sensible; (2) the additional variable added to create the potential DRG reduced the variance in length of stay by a significant amount; and (3) the mean length of stay was statistically different among subgroups. The reformulation process resulted in 23 MDCs and 467 DRGs and was completed in January of 1982. Technical errors and definitional problems became apparent in the following year which prompted a revision of the ICD-9-CM DRGs by Health Systems International which was released in June of 1983 (Coffey and Goldfarb, 1986; Health Systems International, 1983).

In Canada, the Hospital Medical Records Institute (HMRI) developed a congruent case mix system based on Case-Mix Groups (CMGs). CMGs are based upon the ICD9 diagnostic coding system rather than the ICD-9-CM system; there are 23 Major Clinical Categories (MCCs) and 465 CMGs. The difference in coding schemes precludes an identical comparison between the two case mix systems; however, it has been shown through statistical analyses that "...CMGs and corresponding DRGs do, with 96 percent reliability, refer to the same group" (Botz, 1985, p. 40).

Applications of the DRG Classification System

A number of applications of DRGs have been reviewed in the literature. Yoder and Connor (1982) examined DRGs and their significance in management. These authors stated that "Information provided by linking DRGs with other variables is particularly significant in that it creates a bridge between the relatively isolated realm of medical practice and other relatively well-analyzed realms, such as financial management" (Yoder & Connor, 1982, p. 29). The DRG system may also be used to characterize hospital case mix, thus, facilitating intrahospital resource utilization comparisons.

A number of studies have used DRGs in conjunction with other variables to test various hypotheses. Frick, Martin, and Shwartz (1985) used DRGs to analyze the extent to which case mix differences contributed to differences in average cost per case between teaching and nonteaching hospitals. Jones (1985) examined the extent to which patients in teaching hospitals are more costly than the inpatients in nonteaching hospitals in an attempt to isolate the "teaching effect" by holding case mix constant through the use of DRGs, demographic variables, and severity-of-illness measures. From a slightly different perspective, Horn (1983) compared charges and length of stay in various hospitals and found that "...when resource consumption is adjusted for severity of illness, the wide differences among major teaching hospitals and other community hospitals...disappear or become much smaller" (Horn, 1983, p. 31). This study, however, focused on only six disease conditions and four hospitals.

There have been articles reporting the feasibility of applying a DRG/CMG system in Canada. In a fairly recent article, Botz (1985) stated: "Provincial governments and Canadian health care institutions are observing, with considerable interest, the impact that case mix prospective reimbursement, based on Diagnosis-Related Groups (DRGs), is having on the budgets...and operational efficiency...of American hospitals" (p. 40). Zuckerman (1983) believed that a DRG-type system was a feasible development for Canada. He commented that such a system might (1) lead to the improvement of utilization review and quality control functions; (2) facilitate an increased understanding of the practice of medical care and the comparison of similar patients across both physicians and hospitals; (3) provide the basis for a new mechanism for financial control and hospital reimbursement; and (4) provide new opportunities for institutional management and planning (Zuckerman, 1983, p. 71). A recent article by MacKenzie, Markle and Croke (1987), exhibited a more doubtful view of an applied DRG/CMG system in Canada. The authors concluded by stating that it was likely that the future case mix systems will feature a better underlying patient classification system overlaid with an index to explain resource use and it will be at this time that case mix applications will expand dramatically (MacKenzie, Markle, & Croke, 1987, p. 24).

One of the most well-known and controversial application of DRGs is their use in prospective per-case reimbursement schemes. This type of payment system was defined by Williams et al. as "one in which prospective rates are determined on the basis of case type, rather than on a per diem or per admission basis" (Williams et al., 1984, p. 17).

Maryland established the first case-based system, the Guaranteed Inpatient Revenue program (GIR), in 1976. Maryland's program is voluntary and currently applies to approximately one-half of the state's 52 acute care hospitals. The case mix measure was based on ICD-9-CM codes, DRGs, and broad patient service categories and the current rate was based on the previous year's rate (Hellinger, 1985, p. 78-80). New Jersey tested a case-based system in a small demonstration project sponsored by HCFA (Health Care Financing Administration) in 1978-80. In 1979, legislation was passed in response to rapidly rising hospital costs that called for a case-based reimbursement system to be phased in between January 1, 1980 and January 1, 1983. Almost one-third of New Jersey's 93 hospitals joined the system during 1980 and by 1982, all New Jersey hospitals were enrolled in the statewide case-based prospective reimbursement system which used only DRGs to define case mix (Davies et al., 1983; Hellinger, 1985; May & Wasserman, 1984; Rosko, 1984).

The interpretation of DRG weighting factors is of relevance to this study. The HCFA developed weights for each DRG which are intended to reflect the resource consumption relative to other DRGs. Relative DRG weights express the average cost of a case in a specific DRG in comparison with the average cost of all cases (Hellinger, 1985).

Outliers are those cases whose length of stay is extremely long (well over the mean length of stay) or whose costs exceed the average cost by 1.5 times the DRG rate or $12,000 (Hellinger, 1985). These "length-of-stay outliers" or "cost outliers" are reimbursed according to the geometric mean length of stay (GMLOS) for each DRG. The use of the geometric mean rather than the arithmetic mean for outliers was attributed to the highly skewed length-of-stay data; thus, the proportion of cases that will be outliers within each DRG is more predictable.

Limitations of DRGs

As is often the case with the introduction and application of new techniques or methodologies, the limitations and criticisms do not emerge until a period of time has passed. The literature on DRGs is replete with criticisms of the system; often the finger is pointed in one of three directions - the methodology used to develop the system, the application and implementation of the system, or the feasibility of the DRG classification methodology to act as a reimbursement system. Some of the most often cited criticisms of the DRG system are:

1. There may be a "deliberate and systematic shift in a hospital's reported case mix in order to improve reimbursement" (Simborg, 1981, p. 1602). This manipulation of the system is referred to as the DRG creep.

2. Often there occurs inaccurate and/or incomplete recording of diagnostic and surgical information of the discharge abstract which may result in erroneous determination of the DRG category and subsequent reimbursement (Bentley & Butler, 1982; Doremus & Michenzi, 1983; Williams et al., 1984).

3. There exists insufficient clinical homogeneity within DRG groups. Some researchers believe that this is a result of not accurately nor thoroughly measuring the severity of illness component (Horn & Sharkey, 1983; Horn, Sharkey, Chambers & Horn, 1985; Johnson & Appel, 1984).

4. Overall quality of patient care may decline, owing to the incentives created by the reimbursement policies to discharge patients sooner than what might be an appropriate period of time (Meyer, 1986).

5. The DRG classification system is designed with the emphasis placed on what was actually done for the patient rather than on what should have been done and the nature of his or her disease (Gonnella, Hornbrook, & Louis, 1984; Plomann, 1985).

6. The limitations of the statistical classification algorithm used in the development of the DRGs (Williams et al., 1984).

With respect to (3), researchers have stressed the importance of measuring severity of illness in order to create more clinically homogeneous groups for the purposes of quality review as well as for performance comparisons (Horn, Chachich, and Clopton, 1983). This has lead to the development of several direct case mix measures which incorporate severity of illness - Severity of Illness Index, Disease Staging, and Patient Management Paths.

Horn, assisted by a panel of physicians and nurses, developed the **Severity of Illness Index.** The values of seven dimensions which reflect the burden of illness of the hospitalized patient are used to compile the overall manuel severity score. The seven dimensions include: (1) stage of principle diagnosis at admission; (2) complications of the principle diagnosis; (3) concurrent interacting conditions affecting the hospital stay; (4) dependency on hospital staff and facilities; (5) extent of non-operating room procedures; (6) rate of response to therapy or rate of recovery; and (7) impairment remaining after therapy for the acute aspect of hospitalization (Horn, Chachich & Clopton, 1985; Horn & Horn, 1986; Prospective Payment Assessment Commission, 1986). Raters score each of the seven dimensions in 1 of 4 levels of increasing severity. The index was designed to produce groups that were homogeneous with respect to burden of illness. In a study reported in 1985, it was found that "...DRGs explained 28 percent of the variability in resource use per case while Severity of Illness-adjusted DRGs explained 61 percent of the variability in resource use per case" (Horn, Sharkey, Chambers & Horn, 1985, p. 1195). An automated version of the index, Computerized Severity Index (CSI), was expected to be released in the summer of 1986 with the hope of facilitating widespread collection of severity of illness data (Horn & Horn, 1986; Prospective

Payment Assessment Commission, 1986). It appears, however, that reliance on soft data precludes the use of the severity index within the prospective payment system.

Initially, for quality assurance, Gonnella and his colleagues developed a system called **disease staging** which uses available hospital discharge data for measuring severity of illness. It is an approach to measuring disease severity and according to the founders, represents "...a comprehensive case-mix classification system" (Gonnella, Hornbrook and Louis, 1984, p. 637). The system does not depend on actual utilization patterns or on expected response to therapy, but is based on a conceptual model of the disease process itself (Prospective Payment Assessment Commission, 1986). Gonnella et al. further stated that the staging concept is also useful for the comparison of hospital outputs on both a large and case-by-case basis (p. 638).

Disease staging is a clinically based classification system with four major stages, increasing in level of severity. The four stages include: Stage 1 - diagnosis is certain with no complications or problems of minimal severity; Stage 2 - disease process is limited to an organ or system with a significantly increased risk of complications; Stage 3 - multiple site or generalized systemic involvement with a poor prognosis; and Stage 4 - death (Ament, Dreachslin, Kobrinski & Wood, 1982; Coffey & Goldfarb, 1986; Gonnella & Goran, 1986; Gonnella Hornbrook & Louis, 1984; Prospective Payment Assessment Commission, 1986).

Disease staging, an exclusive case mix methodology, has been compared with other classification systems such as DRGs and cross-classification of the CPHA with respect to variation in total patient charges accounted for, explanation of resource consumption, and the impact on reimbursement by type of hospital. Ament et al. (1982) found in their study on the suitability of three case-type classification systems for use in reimbursing hospitals that while DRGs and cross-classification were more homogeneous within case-types than disease staging, none accounted for "...enough variance to permit straightforward use of case-type standard costs in a reimbursement mechanism" (Ament, Dreachslin, Kobrinski, & Wood, 1982, p. 460). In a study reported four years later, it was found that DRGs and disease staging "...perform similarly in explaining length of stay variation..." but that "...the two systems generate substantially different reimbursements by type of hospital" (Coffey & Goldfarb, 1986, p. 814). McMahon and Newbold (1986) in their study on variation in resource use within DRGs showed that in common elective surgical procedures, there was little variability in disease staging whereas in those medical groups that are usually not elective in nature, disease staging showed more variability (McMahon & Newbold, 1986). A weakness of disease staging is its questionable ability to measure severity of illness with enough accuracy to completely discern differences among patient groups (Coffey & Goldfarb, 1986).

Patient Management Paths were developed by Blue Cross of Western Pennsylvania using an original database from 90 Western Pennsylvania hospitals (Prospective Payment Assessment Commission, 1986). It is an approach to case mix measurement which interrelates symptoms, diagnosis and treatment rather than basing classification on discharge diagnosis singly or in conjunction with other variables such as secondary or multiple diagnoses, procedure, and age. Young and her colleagues (1982) pointed out that "patients who are clinically similar, and even the same patient, can have a number of diverse, but appropriate, reasons for being in the hospital, and their use of hospital resources in each hospital episode will differ accordingly" (Young, Swinkola, & Zorn, 1982, p.501).

The underlying belief of this classification methodology, according to Bentley and Butler (1982), is that physicians diagnose and treat their patients based on the knowledge of immediate symptoms and not on the ultimate diagnosis which may be confirmed some days after the patient has been admitted (Bentley and Butler, 1982). Patient Management Paths can be developed with a three step process: (1) patients are grouped based on manifest symptoms at the time of admission; (2) the diagnostic and treatment services that are available and applicable to each patient admitted are identified; and (3) the paths or algorithms are weighted (by cost) to obtain an index that reflects the relative cost of each type of patient (Bentley & Butler, 1982; Young, Swinkola, & Zorn, 1982). Owing to the vast number of categories that could result from an admission-based classification system, this methodology was not developed with the intention of capturing every unique disease presentation nor are the diagnostic and treatment algorithms associated with each category intended to be exhaustive. Rather, patient management paths describe the diagnostic and treatment components of a "typical" patient (Bentley & Butler, 1982).

Various studies have shown that severity-of-illness measures account for some of the variability in resource utilization within DRG categories (Horn & Sharkey, 1983; Horn, Sharkey, Chambers & Horn, 1985). McMahon and Newbold (1986), however, pointed out that most studies to date have "... not attempted to assess the effect of other known sources of resource variation such as differing physician practice patterns" (McMahon and Newbold, 1986, p. 388). They also alluded that often in these studies, there was an implicit assumption that resources are used in direct proportion to the severity of the patient which often may not be the case if further medical intervention is futile (McMahon and Newbold, 1986). Recently, it has been shown that in the trimmed surgical groups "...a significant amount of residual intra-DRG variability is accounted for by the physician" (McMahon and Newbold, 1986, p. 394).

2.2.4 Summary

Three major applications of classification methodologies were reviewed. Disease classification was the earliest classification system developed and used in the health care field. The limitations of an etiologically based system for resource allocation, however, stimulated the development of alternate classification methodologies. Patient classification systems were designed to categorize patients according to observed similarities of patient characteristics rather than disease etiology. Two methods of patient classification were described. Classification by levels of care entailed categorizing patients according to the amount of direct nursing care needed. Types of care classification schemes, on the other hand, were developed to facilitate the placement of patients into the most appropriate program of facility according to their needs. To facilitate interhospital comparisons of resource use and to promote equitable resource allocation decisions, hospital classification systems were developed. The indirect approach to measuring case mix focused on surrogate measures such as the number of beds or clinical services. The direct approach relied on large sets of patient specific data to form relatively homogeneous diagnostic categories. The latter approach was shown to more accurately explain differences between hospitals. Currently, the DRG classification system is the most highly developed system for measuring hospital case mix. However, several approaches to measuring severity of illness have been proposed in an effort to produce more homogeneous diagnostic categories.

2.3 Concepts Related to Health Services Utilization

Pertinent to this investigation are the concepts related to health services utilization. In order to allocate resources with efficiency and effectiveness, an understanding of utilization behavior is imperative. Two conceptual aspects of relevance are reviewed: (1) relationships among the concepts of need, demand, access, and utilization; and (2) determinants of health care utilization.

2.3.1 Concepts of Need, Demand, Access, and Utilization

A plethora of terminologies defining the concepts of need, demand and access characterize the literature published on the utilization of health care. Often, these words are used interchangeably by authors indicating the ambiguity and controversy that encompass them.

Need appears to be the most imprecise of these concepts and one that is difficult to measure. This is, perhaps, because "...the perception of need is likely to vary from patient to patient and physician to physician" (Fuchs, 1968, p. 190). There are at least two perspectives in the literature on need - that of the individual and that of the provider (Aday, Andersen & Fleming, 1980; Donabedian, 1973; Hulka & Wheat, 1985). Feldstein (1966) and Boulding (1966) declared that the need for medical services was the amount of care that the physician believes is necessary. Ohmura (1978) described need as an individually perceived state that occurred when the person made a decision to seek medical care. It has been further stated by Donabedian (1973) that the concept of need should be used to describe "...states of the client that create a requirement for care and therefore represent a 'service-requiring potential'" (p. 65).

Some researchers combined both the consumer and provider perspectives in an attempt to clearly define the concept of need. MacStravic (1978, p.4) stated that "...need is first defined by the consumer's decision to seek health services, then by the professional's decision to render or prescribe health services to a given patient...". Donabedian (1973) pointed out that when the perspectives of consumer (patient) and provider (physician) are incongruent, the result is "unmet-need" (unrecognized by either provider and/or the client). Despite the fact that need has in some cases been defined strictly from a consumer perspective, it appears that generally, this concept is more accurately defined by those rendering service.

The conflict between individually-perceived need and medically-determined need appears to originate firstly from the reality that the patient does not have the medical education, knowledge, and training that the provider has to confirm need (Boulding, 1966) and secondly, from the lack of a clear definition of health itself. Donabedian (1973, p. 64) noted that

> Congruence in the definition of need should increase as clients learn more about the professional viewpoint through formal education and through personal experience of medical care, and as professionals broaden their own viewpoints to embrace nonsomatic disease and to acquire greater sensitivity to the interrelationship between social and health needs.

Planners, administrators, and other professionals in the health care field recognize that health care resources are not limitless. Also, there is an urgency, in the face of rapidly rising costs, to allocate resources in the most optimal way; that is, it is important to identify those in need of services. Owing to the problems of clearly defining the concept itself, it is difficult to operationalize need and according to one author, the concept of need is "...of little value for analytical purposes" (Fuchs, 1968, p.190). However, the effort to quantify the need for health services has been made. Measures of need range from those that are diagnosis-based (Goldfarb, Hornbrook & Higgins, 1983; Hurtado & Greenlick, 1971) to those that are based on symptoms and on the individual's own perception of him- or herself (Aday & Andersen, 1975; Phelps, 1975). The results of some studies conducted to evaluate the impact of need on utilization of health services lead to the conclusion that need is the major determinant of use of health care services (Hulka & Wheat, 1985) while other researchers concluded that there is no relationship between need and 'intensity' of utilization (Wennberg, 1979). The conflicting results could be caused, in part, by the definitional problems with the need for health services.

Also found in the literature were a number of definitions and meanings for the demand of health services. Although a comparatively less elusive term than need, the concept of demand itself has serious weaknesses and limitations (Boulding, 1966). Boulding (1966) described the demand for care to be what the client wants while Phelps (1975) defined demand as the "number of people trying to obtain medical services" (p. 105). Feldstein (1966) dichotomized demand into 'initial demand' (initiated by the patient) and 'derived demand' (physician initiated). Feldstein further stated, however, that in order to explain the use of health care services, the supply of resources must also be considered (p. 129).

Rather than considering the concept of demand in isolation of other pertinent factors, some researchers have defined demand with reference to need. Warner, Holloway and Grazier (1984) stated that need and demand are not synonymous terms but that to forecast demand, the need for health services can not be ignored. The authors developed a model illustrating two overlapping circles - one circle representing the amount of services needed and the other representing the amount of services sought. Demand, then, is defined by services both needed and sought plus those services sought but not needed (p. 255-256). Griffith (1972) also related demand and need. First of all, he divided demand into 'explicit demand' (explicit requests for services either by the patient or the physician) and 'unexpresssed demand' (demand which is not translated into explicit demand, often because of resource shortages). Griffith (1972) summarized the distinction between explicit demand, unexpressed demand, and need by delineating six possible states in which a patient could be: (1) with need, without demand; (2) with need, with unexpressed demand; (3) with need, with explicit demand; (4) without need, with explicit demand; (5) without need, with unexpressed demand; and (6) without need, without demand (p. 21). Review of the literature indicated that, like need, demand is also defined according to two perspectives -- that of the consumer or patient and that of the supplier. In addition, the concept of need plays an important role in determining demand.

The concept of access has been referred to as a multidimensional one (Andersen et al., 1983). Need, demand and utilization are terms often found interspersed in the literature on this topic. Andersen et al. (1983) stated that there were two main themes regarding the access concept: (1) access is equated with characteristics of the population such as family income and attitudes toward medical care; and (2) access is equated with characteristics of the delivery system such as the distribution and organization of manpower and facilities. Aday, Andersen and Fleming (1980) have defined access "...as those dimensions which describe the potential and actual entry of a given population group to the health care system" (p. 26). They further described potential access as the probability of an individual gaining entry into the health care system; the entry being influenced by both the structural characteristics of the system and the perceived wants and needs of the individual. Realized access on the other hand reflects the utilization of services and is evaluated by consumer satisfaction and utilization indicators. Aday, Andersen and Fleming (1980) believed that "...greater parsimony in describing access levels can result if we develop a better idea of the relationships among the plethora of indicators currently used to represent the concept" (p. 27).

The concepts of need, demand, and access have been defined in many ways and often used interchangeably depending upon the orientation of the researcher and the purpose to which the concepts are directed. However, the concept of "utilization" is rarely defined explicitly in the literature. Need, demand and access are terms which appear to interact to describe, forecast, and evaluate the utilzation of health services. Aday and Eichorn (1972) have summarized the indices used to compute utilization in a research bibliography. Some of the indices used to measure physician utilization are number of visits, type of visit and type of physician specialty; hospital utilization indices consist of volume of services consumed, type of hospital, type of services and type of admission (p. 11-13).

2.3.2 Determinants of Health Care Utilization

In light of the vast number of variables which appear to affect the utilization of health care services, researchers have attempted to categorize the determinants using various approaches. Hulka and Wheat (1985) reviewed the literature on factors influencing health care utilizaton according to five categories: (1) health status and need; (2) demographic characteristics; (3) physician availability; (4)

organizational characteristics of health care services; and (5) financing mechanisms. Earlier, Anderson (1973b) also reviewed five different approaches that have been used to study the utilzation of health services; these are: (1) sociocultural approach; (2) sociodemographic approach; (3) social-psychological approach; (4) organizational approach; and (5) social system approach. Acknowledging that the last approach is often employed in too narrow a fashion as are the other approaches, Anderson (1973b) suggested that the social system model that develops causal structures may be the most valuable methodology to provide insights into utilization behavior.

Andersen & Newman (1973) condensed the aforementioned approaches into three categories: (1) societal determinants; (2) organizational determinants; and (3) individual determinants which will be discussed in the following sections.

2.3.2.1 Societal Determinants

The main societal determinants of health utilization are technology and norms (Andersen & Newman, 1973). Technology, in some instances, has had a negative impact on the utilization of health services. Andersen and Newman illustrated this point when they reviewed the history of tuberculosis treatment and the decline in the use of TB hospital services that can be attributed to public health efforts (p. 103). On the other hand, other technological developments in the fields of surgery, radiology, and nuclear medicine have decidedly increased the utilization of health services (Andersen & Newman, 1973).

There is little doubt that the advances made in medicine, to this date, have resulted in the eradication of some diseases and the lengthening of life expectancy (Russell, 1976). However, there are some less desireable repercussions from the rapid medical technological advancement. Fuchs (1968) put forth the problem of the "technologic imperative" which implied that the medical profession used the "latest" treatment without, perhaps, weighing benefits against costs. In this regard, Wennberg (1979) concurred with Fuchs when he suggested that physicians do not do their best "...to learn about the impact of new medical technologie on patient outcome before advocating their adoption into routine practice" (p. 121). Assuredly, the development and application of new medical technology contributes to the utilization of health services and subsequently to health care costs.

Societal norms also affect the utilization of health services. According to Andersen and Newman (1973):

> The normative component of the societal determinants can be reflected through formal legislation as well as growing consensus of beliefs and homogeneity of values which pervade the society (p. 13).

They further stated that the societal norms which have the greatest effect on utilization patterns have to do with how medical care is financed (Andersen & Newman, 1973).

Prior to the mid 1950's, Canadians were largely responsible for financing their own health care. Today, however, Canadians have access to medical care independent of their financial situation. This "public" health care system was the result of two federal health acts. The Hospital and Diagnostic Services Act of 1958 provided financial assistance to provincial hospital plans that made prepaid coverage universally available to all Canadian residents, including diagnostic services to in-patients and a broad range of out-patient services. The formalization of insurance coverage, together with increased bed availability, provided no incentive to use less expensive facilities or methods of treatment (Meilicke & Storch, 1980). Ten years later, in 1968, the financial barriers to medical services were removed through the Medical Care Act. Though an immediate rise in hospital utilization followed the passage of these Acts, the rate of increase stabilized after a few years (Meilicke & Storch, 1980; Vayda, Evans & Mindell, 1979).

Despite the stabilization of high utilization rates, the consumers of health care have become increasingly informed about the "product". While enthusiastically supporting the medicare principles, consumers have established an ethic that relates to a right to health care (Maher, 1987, p. 23). While public expectations toward health care rise, Fox (1980) noted the preoccupation with medical uncertainty. In his article, Fox stated that "public tolerance of medical uncertainty appears to have diminished, and indignation about its persistence has grown" (Fox, 1980, p. 19). Thus, a paradox exists whereby consumers demand and expect the medical field to solve all health problems while at the same time they are apprehensive about the side-effects which may result from the endeavours to alleviate those problems (Illich, 1975). As medical technology increases and consumer awareness heightens, this paradox is likely to sharpen.

2.3.2.2 Organizational Determinants

A review of the literature indicated that components of the health care system itself were factors to be considered in the study of health services utilization. The major factors were hospital bed supply, physician manpower and specialty mix.

Roemer (1961) tested the hypothesis that the supply of beds was a major influence on the hospital utilization rate. His finding, that "the number...of hospital beds... substantially determined the hospital utilization rate of the local population" (p. 41) is often referred to as Roemer's Law: an increase in hospital bed availability will lead to an increase in utilization. The results from a number of later studies concurred with the postulate (Anderson, 1973a; Cannoodt & Knickman, 1984; Harris, 1975; Knickman & Foltz, 1985; Rogatz, 1974) but some studies have suggested that the effect of Roemer's Law is mediated by phyisican behavior (Rothberg, 1982).

The relationship between physician supply and utilization has also received considerable attention. Again there seems to be evidence supporting the notion of supply-induced demand. Wennberg and Gittelsohn (1973) examined the extent to which bed and manpower use, expenditures and utilization varied among hospital service areas in Vermont. They concluded that the supply of general surgeons had a postive impact on the surgery rate and that those service areas with a higher supply of physicians who do not perform surgery have lower surgery rates. Other studies conducted in various parts of Canada and the U.S. have also correlated the supply of physicians and/or beds with increased utilization (Bunker, 1970; Lewis, 1969; Stockwell & Vayda, 1979; Vayda, Morison & Anderson, 1976).

Despite the overwhelming evidence to support the hypothesis of supply-induced demand, there are researchers who refute the supposition. In Weil's article, "Do more phyšicians generate more hospital utilization?", he concluded that "...once there is a 'sufficient' number of phyisicans to meet a service area's needs, adding physicians does not necessarily increase the total volume of patient days..." (Weil, 1981, p. [illegible]). Wilensky and Rossiter (1983) and Berk, Bernstein and Taylor (1983) used data from the National Medical Care Expenditure Survey and in their conclusions, concurred with Weil regarding the supply-induced demand postulate. More recent studies have supported the supply-induced demand explanation in general, but have noted the interactive effects of nursing-related variables, admission-related variables (Cannoodt & Knickman, 1984) and the availibility of beds in long-term facilities (Knickman & Foltz, 1985). With the controversy surrounding physician-inducement demand, it is not surprising that the issue of unnecessary surgery has emerged in the literature. Some experts showed that there was wide geographical differences in surgical rates and that these differences in use often did not reflect differences in need for surgery (Roos & Roos, 1981, 1982; Wennberg & Gittelsohn, 1973). In an effort to curb unnecessary operations, second opinion (SO) consultation programs have been initiated in some areas. To evaluate these programs, cost-benefit studies were conducted and the researchers concluded that SO programs were clearly cost effective (Martin et al., 1982; Ruchlin, Finkel & McCarthy, 1982). However, Brook and Lohr (1982), while acknowledging the deterence of surgery and the financial savings that were realized with the implementation of SO programs, pointed out that they most likely "...prevent the performance of elective operations at a time when the patient is at lower risk of adverse sequelae...and deter both needed and unneeded surgery..." (p.2).

The issue of unnecessary surgery provided the impetus for researchers to explore the relationship between volume of surgery and adverse outcomes (post operative morbidity and/or mortality). Various studies demonstrated that those facilities that experience higher volume generally had lower mortality rates (Bunker, Luft & Enthoven, 1982; Luft, 1980; Luft, Bunker & Enthoven, 1979; Maerki, Luft & Hunt, 1986). However, these studies have been unable to establish whether higher volume lead to better outcomes or better outcomes lead to higher volume. Irrespective of the causal pathway, regionalization of selective surgical procedures was supported by the research.

2.3.2.3 Individual Determinants

Though societal and organizational determinants have been shown to have an influence on health services utilization, more attention has been placed on various demographic characteristics as explanatory variables in the study of health services utilization. Rothberg (1982) believed this occurred because the focus of many of the early contributors (sociologists and public health researchers) was demographics.

Andersen, in 1968, developed a sequential, behavioral model which illustrated the conditions affecting an individulal's decision to seek medical care. This widely used theoretical framework was made up of three components: (1) predisposing component; (2) enabling component;

and (3) illness level (need). Predisposing variables were those individual caharacteristics that existed prior to the onset of illness by which the propensity toward use could be predicted (Andersen & Newman, 1973). They encompassed three subcomponents: (a) demography; (b) social sturcture and (c) attitudes or beliefs about medical care, physicians and disease. The second component was labelled as "enabling" owing to the fact that despite the predispostion of individuals to use health services, there must be some means available for them to do so. An enabling factor was defined as "a condition which permits a family to act on a value or satisfy a need regarding health service use" (Andersen & Newman, 1973, p. 109). Both family elements such as income and health insurance and community elements such as ratio of health personnel and facilities to the population were incorporated in the enabling component. The third and last component is that of illness level. In order that utilization of services takes place, a person must perceive illness and the need for care. Additionally, an evaluation by medical professionals of the perceived illness level must occur.

Age has been described as an immutable variable "...related to use of health services through (its) biologic contribution to morbiditiy and mortality" (Hulka & Wheat, 1985, p. 446). A variable frequently analyzed, Guzick (1978) found that there was a U-shaped relationship between age and health services utilization - bottoming out in the 5-17 age group. Wilson (1981) investigated the characteristics of hospital use by the elderly in 42 lower peninsula Michigan communities. He noted the "elderly have a mean level of hospital use...approximately four times that seen in the general popualation" (Wilson, 1981, p.332).

The relevance of sex as an influencing factor in health services utilization was investigated. Andersen & Anderson (1979) examined the trends in the use of helath services over a number of years and found that with respect to admissions, females had a consistently higher admission rate than males; due mostly, they reported, to pregnancy and complications of pregnancy. Hibbard & Pope (1983) and Hulka & Wheat (1985) also looked at gender and its role in health care utilization. The results of these studies concurred with the above trends demonstrated by Andersen & Anderson (1979). More symptoms were reported by women than men and one study found that "women have a greater interest and concern with health and that this factor is important to both the perception of symptoms and utilization rates for females" (Hibbard & Pope, 1983, p. 137). Thus, there appears to be some interactive relationship between a womens's concern with her health, her perception of various symptoms and her utilization of services. However, Hulka and Wheat (1985) referred to work done by Nathanson in 1977 which found that women's greater utilization of health services persisited even when their higher levels of perceived morbidity were controlled (p. 447).

A number of studies have provided evidence that ethnicity has an effect on the utilization of hospital services. Rothberg (1982) cited two studies both of which found that whites used more health services than nonwhites. However, in a recent article, Wilson, Griffith and Tedeschi (1985) noted that the relationship between race and hospital use (in the U.S.) was complicated by other affecting demographic, economic and social variables and as these variables changed, so did the relationship between race and utilization. Wilson, Griffith and Tedeschi (1985) found no statistically significant difference in race-specific use for 23 Michigan communities and attributed the slightly higher use by blacks to higher morbidity and lower socioeconomic status. Roos and Roos (1982) in an effort to discern whether surgical rate variations in elderly people reflected health or socioeconomic characteristics found that those areas with disproportionately large numbers of Anglo-Saxon parentage had high surgical rates as well as those areas that contained a more educated population. The high rate areas were not characterized by a population that was disabled and of ill health.

Age, sex and ethnicity were not the only influential, predisposing factors studied. Other studies have related marital status (Morgan, 1980), social networks and social support (Berkanovic & Telesky, 1982; Blake, Roberts & Mackay, 1980), fitness and lifestyle (Shephard, Corey, Renzland & Cox, 1983) and employent and the sense of well-being to the utilization of health services (Wheeler, Lee & Loe, 1983). Most studies were of a multivariate nature in an attempt to identify factors singly affecting health services utilization. However, the complex relationship between demographic variables (age, sex, marital status), social structural variables (race, occupation, family size) and values and attitudes toward health care precludes any definitive conclusion with respect to the exact effect they have on utilization.

Though individuals may be predisposed to use health care services, the means must be available for them to do so. Enabling conditions can be measured by family resources (insurance, regular source of care) as well as community resources (urban/rural nature).

Numerous studies have been conducted to evaluate the impact of "free" medical care (with the introduction of health insurance) on the use of health services. With the introduction of health care insurance, the existing financial barriers were relaxed or removed and utilization increased in Canada (Enterline, Salter, McDonald & McDonald, 1973; Greenhill & Haythorne, 1972; Vayda, Morison & Anderson, 1976) and in the United States (Berk, Bernstein & Taylor, 1983; Benham & Benham, 1975; Phelps, 1975; Shortell, 1975). Family income, therefore, did not appear to have a large influence on utilization owing to the availability of insurance (Roos & Roos, 1982). It was further shown that reduction in out-of-pocket cost to the poor was an important reason for increased utilization (Aday, Andersen & Fleming, 1980; Andersen & Newman, 1973). The interim report from the Rand Health Insurance study indicated that those covered by comprehensive (free) health insurance used more health care services than those who shared the cost (Korcok, 1984; Newhouse et al., 1981). The question whether or not the increased use led to improved health was investigated in the second Rand report. Though it was reported that "free" health insurance did not lead to improved health status, weaknesses in the study such as limited measures of health status and the exclusion of the young, elderly and disabled population groups precluded any meaningful comparisons of overall health.

A regular source of care was cited as an important enabling factor. Harris (1975) stated that the way people use hospitals depended on the way medical care was delivered to them and the type of resources available to them. The dimensions of access to medical care were explored by Andersen et al. (1983) and they reported that a particularly important enabling condition was a regular source of care. They further stated that "People without a regular source of care and with long waiting time have the least use relative to need" (Andersen, McCutcheon, Aday, Chieu & Bell, 1983, p.71). Distance and travelling time were shown to negatively affect the utilization of services (Miners, Green, Salber & Scheffler, 1978). However, owing to the interaction with other predisposing and enabling factors (Weiss & Greenlick, 1970), it was difficult to discriminate what exact effect they have on utilization. Berk, Bernstein & Taylor (1983) found no difference in utilization of health services by rural residents who had longer travel time (than urban residents) to the source of care.

Characteristics of the community can also affect the utilization of health care. The urban versus rural location was one of the earliest suspected predictors of hospital use (Rothberg, 1982). The conflicting evidence made it difficult to ascertain the degree to which urban-rural distinctions affect utilization. Traditionally, urban residents used more health services than rural residents (Bashshur, Shannon & Metzner, 1971; Greenhill & Haythorne, 1972) but recent evidence illustrated that the rural population surpasses the urban population with respect to use (Szafran, 1985; Maher, 1987). This phenomenon may be partly due to the expansion and improvement of freeways and roads connecting cities to the rural areas.

Given the presence of both predisposing and enabling conditions, the individual must perceive illness (Andersen, Kravits & Anderson, 1975); "Need, then, is the stimulus or most direct reason for health service use" (Andersen, Kravits & Anderson, 1975, p.6). It has been further stated by Andersen & Newman (1973) that illness level "...is the major determinant of utilization" (p. 114). McFarland, Freeborn, Mullooly & Pope (1985) in a recent study on utilization patterns found that "The consistently high users were more likely to perceive their health status as fair or poor..." (p. 1228) and experienced a higher degree of psychological distress. It was further reported by these researchers that use of health services was unrelated to marital status, income, occupation, perceived social class, smoking and alcohol consumption.

2.3.3 Summary

Two major aspects relevant to the utilization of health care were reviewed. The concepts of need, demand and access were interspersed throughout the literature with the definitions of each often dependent on the writers' orientation and purpose. It was concluded that need plays an important role in determining demand. The determinants of health care utilization were reviewed in three parts -societal determinants, organizational determinants and individual determinants. There is no doubt that advancing medical technology has an impact on hospital utilization and costs. As well, the norms of a society affect the way individuals use the health system; in particular, the way in which health care is financed. Bed supply, physician manpower and specialty mix are three elements of the organizational component that affect the utilization of health services. Individual determinants were presented with reference to a theoretical framework encompassing predisposing, enabling and need components.

2.4 Funding of Alberta Hospitals

A major issue in the health field is the efficient use of resources. Those involved in the delivery of health care in developed countries are aware of the ever escalating costs of that delivery and of the necessity to bring those costs under control (Evans, 1984, p. 23). In the following three sections two funding policies applied in Alberta will be reviewed briefly as well as the subject of costs in Alberta hospitals.

2.4.1 Global Funding

The global budget funding policy was introduced by the provincial government in 1971 in response to the growing concern of spiraling hospital costs. Initially implemented on a trial basis in the four provincially owned hospitals, the system was operational in all Alberta hospitals by 1972 (Alberta Department of Health, 1970). Global budgeting is described as:

> a system of government financing of hospital expenditures in which an over-all sum of money is granted by the provincial government to the hospital to meet it's annual approved operating costs. The global concept is embodied in the fact that, once the grant is made, the hospital governing board has the authority and the responsibility of administering those total funds without direct accountability in respect of specific expenditures (Chatfield, 1980, p. 11-12).

Impact of Global Funding

In reviewing the literature, one problem of relevance to the thesis topic became apparent - the inequitable allocation of resources to

Alberta hospitals. Global funding is based on the premise that the government and the hospitals will agree on the standard and level of services provided by hospitals. Chatfield (1980) argued that inequities in resource allocation to hospitals exist because it is difficult to arrive at a standard or quality of service at a mutually agreed upon cost. Chatfield contended that inequities are further exacerbated by the fact that some hospitals are more proficient than others in negotiating for additional funds.

Vanhooren (1981) concurred with Chatfield with respect to inequitable resource allocation. However, he believed the source of the inequities to be a result of the method by which the global budget is calculated. The basis for the budgetary allocation is the previous years' allocation plus an incremental change to recognize the fluctuations in inflation and some [illegible] of changing workloads and program developments. It is believed [illegible] that this funding policy fosters a 'use it or lose it' or 's[illegible]e, get more' mentality among institutions (Coombs & Richter, 1986; Vanhooren, 1981). Coombs and Richter (1986) stated that this latter element "...has not served us well and certainly has not met the test of equity" (p. 21).

The global budgeting system does not link expenditure with output (Evans, 1975), and some feel that if it did the result would be a more rational and effective funding policy (Coombs & Richter, 1986). Evans (1975) claimed that since "expenditure data are based on inputs, neither the hospital nor the provincial government understands the total costs of inpatient care in a given hospital" (p. 152).

Vanhooren (1981) not only concurred that the global budgeting system does not link expenditure with output but that the present system was a political tool on the part of the Alberta government to control hospital expenditures (p. 38). The real problem, according to Vanhooren, is over utilization of hospital services and this, he feels, is encouraged by the global budgeting system. He further stated the intent of the system is to provide an arbitrary percentage of funds to hospitals and remain at arm's length from any cost allocation decisions that must be made by the hospitals "...knowing full well that funds are insufficient to meet the demand or utilization of the institutions" (Vanhooren, 1981, p. 39).

In summary, some of the problems with global funding are:

(1) lack of incentives for hospital management to provide their most efficient and effective health care delivery;

(2) inequitable allocation of funds among hospitals within the province;

(3) a tendency to penalize efficient hospitals and benefit inefficient hospitals; and

(4) inaccurate adjustments to account for the impact of increases in volume or program additions.

2.4.2 Pilot Funding System

It has been suggested that if hospital funding was based on a 'per unit' reimbursement system, there would be an immediate incentive for the organization to operate efficiently and effectively (Vanhooren, 1981). In an effort to alleviate some of the problems associated with the global funding system, and to test an alternate policy, the Department of Hospitals and Medical Care (DHMC) introduced a volume-based trial funding system in three Alberta hospitals: Foothills Hospital, Medicine Hat and District Hospital and Drumheller Regional Health Complex. The system was introduced in the 1983 fiscal year and continued for three years, ending officially in 1985/86.

Under the Pilot Funding Study, the government's payment to the three hospitals changed from a global budget to a payment per discharge. Variable funding rates for inpatient services, outpatient visits and auxiliary hospital patient days were calculated for each hospital and a hospital's budget was obtained by multipling the variable funding rates by the negotiated workload volumes and adding fixed costs.

With this funding system, the focus was shifted from a 'global' perspective to a 'unit' perspective. Coombs and Richter (1986) stated that if within limits, "...the hospital may keep the difference or allocate it to other priorities" (p. 21) when savings were realized.

Published comments on the success or failure of the pilot funding study are few. However, staff at the Foothills Hospital in Calgary believe this "...is a more rational funding system and a more effective planning and control tool" (Coombs & Richter, 1986, p. 21). Departments in the hospital had more incentive to contain costs as well as deliver the necessary quantity of services.

2.4.3 Growth of Hospital Costs

> One of the outstanding features of the health care system has been the persistent rise in the cost of hospital care, which accounts for some 40 percent of the total cost of health care in the country" (Auer, 1987, p. ix).

Auer (1987) prepared a study for the economic council of Canada in which the growth of hospital costs in Canadian provinces were examined from

1961 to 1979/80. Two components were investigated - population-based indicators such as population growth and aging of the population and utilization-based measures such as higher wages and prices as well as greater service intensity.

Auer (1987) stated that most of the increase in hospital costs did not come from population growth but from growth in per capita hospital expenditures. Furthermore, the increase in per capita hospital expenditures was caused not by higher admission rates but from higher costs per admission (p. 20).

Over the past two decades, cost per hospital patient increased at an average annual rate of 1[illegible].9 percent in Alberta (increase in Canada was 12.6 percent). The inpatient care by the nursing department accounted for 35 percent of the increase while administrative and supportive services accounted for 36 percent.

> It is noteworthy, and perhaps surprising, to find the administrative and supportive (i.e., central administration, dietetics, plant operation, housekeeping, laundry, medical records, and linen) contributed as much to the rise in hospital operating expenditures as all inpatient care by the nursing department (Auer, 1987, p.20).

Diagonstic and therapeutic services, supplies and drugs, and education accounted for the remainder of the increase in costs. Auer (1987) further found that wage rates, prices of hospital supplies and service intensity were the key elements accounting for the rise in inpatient costs for all hospital departments with wage rates accounting for about two-thirds of the increase in Alberta.

2.4.4 Summary

The previous section reviewed the global funding policy and the pilot funding project implemented by the DHMC. Several limitations of the global budgeting concept were identified and some researchers believe a more rational funding program should be initiated to provide incentives for cost containment and more effective management of hospital resources. On a trial basis, the DHMC implemented a volume-based funding project in three Alberta hospitals. Regarding this system, Coombs and Richter (1986) wrote that it is "...now the busiest department, not the noisiest, that gets funds" (p. 21). The increase in costs in Alberta hospitals was reviewed and it was found that the increase in per capita hospital expenditures was caused by higher costs per admission [illegible] rates accounting for about two-thirds of the increase.

2.5 Chapter Summary

A review of the literature pertinent to the purpose and objectives of this study indicated that:

(1) Patient origin-destination methodologies are valuable techniques for quantifying patient care-seeking behaviors from a geographic (service area) and a demographic (service population) perspective. Notable progress was achieved in origin-destination research with the knowledge that a hospital service population could be algebraically determined without reference to a predefined geographic area. The most current origin-destination studies have incorporated population-based per capita measures from both a community and a provider perspective to facilitate meaningful interpretations of utilization rates.

(2) There are three major applications of classification in the health

care field: disease classification, patient classification, and hospital classification. Disease classification represents the most widely used system of classification, although the etiologic foundation of disease classification limits its capacity to differentiate the wide variability among diagnostic categories. Patient classification by types of care and by levels of care were designed to group categories of patients according to observed similarities of manifest needs and requirements for nursing care, respectively. Although these two patient classification methodologies attempted to effect the appropriate placement of patients and the rational allocation of staffing personnel, they were not intended to facilitate equitable resource comparison and allocation among health care facilities. To that end, hospital classification was developed which attempted to differentiate hospitals on a variety of dimensions. The inherent complexity and multidimensional nature of hospital output resulted in the creation of numerous indirect and direct measures for estimating a hospital's case mix. The DRG classification system was found to be the most widely applied, current technique for directly estimating the volume and type of cases treated by a hospital.

(3) There is an absence of a cohesive theory of health services utilization. Fragmented conceptual models have been developed; but there appears to be ambiguity and general misunderstanding surrounding the definitions and interrelationships of the concepts relevant to these models. In conjunction with the confusion regarding the concepts of need, demand, access, and utilization, the research revealed numerous societal, health delivery system, and individual determinants which

influence utilization; however, the relative impact of these factors remains to be determined. Given that the determinants of utilization are closely interwoven with the concepts underlying utilization, this outcome is not unexpected.

(4) The global funding policy applied in Alberta has several limitations with regard to cost containment and effective management incen[illegible]t is felt by some that a more rational funding program should [illegible]tiated. A volume-driven funding project, initiated on a trial basis in three Alberta hospitals, has been reviewed as a favorable alternative.

CHAPTER III

RESEARCH METHODOLOGY

The purpose of this study was to explore the feasibility of developing population-based resource allocation and utilization measures and to subsequently use these measures to compare utilization patterns and workloads among selected hospitals and geographic regions in Alberta. To achieve this purpose and other associated objectives, three phases were implemented: (1) formation of a research strategy; (2) development and manipulation of relevant data files; and (3) application of necessary data analysis strategies. These phases are discussed in the following sections.

3.1 General Research Strategy

The conceptual framework to be used for this project was the hospital service population model previously developed by Bay and Nestman (1980, 1984). The model used both hospital utilization data in terms of separation abstracts and census data tabulated by five-year age groups, sex, and general hospital districts (GHDs). With this model, patient origin-destination flow matrices were constructed and relevance and commitment indices were computed (Griffith, 1978; Griffith, Restuccia, Tedeschi, et al., 1981; Bay and Nestman, 1980, 1984). In addition, it permitted the derivation of various population based statistics such as the Bed Distrubution Index (BDI) and the Service Population Index (SPI). Although the model developed by Bay and Nestman was conceptually sound and offered some potential for practical utility, application in the field of resource allocation was limited because of the lack of hospital output measures which reflect resource consumption and case-mix variation.

As a proxy measure of resource use, the model developed by Bay and Nestman used both SEP (the number of separations or admissions) and PDAY (the number of patient days). The SEP measure ignored the variation in resource consumption among various types and levels of patients. Thus, it tended to penalize secondary or tertiary care hosptials. The PDAY measure had less variablility than SEP in terms of resource consumption per unit (patient-day) but it had significant draw backs in terms of actual implementation of the model because PDAY as a measure of hospital output tends to encourage a longer stay. Further, both measures ignored the diagnoses or procedures performed as well as case mix variation; thus, medical input was omitted entirely. The other weakness of the model was the relative complexity of the computational procedures which inhibited practical application of the model by health care planners.

Although the basic conceptual framework was retained from the previous work of Bay and Nestman, for this thesis it was proposed that the deficiencies be remedied and that the model be made more practical and accessible to hospital planners and resource managers by adding the following features:

1) DRG data was utilized in the measurement of hospital resource utilization. Although the DRG as a measure of case mix is not perfect (Johnson & Appel, 1984), it constituted a considerable improvement over the measures previously used - SEP and PDAY. Since the US government is

using this classification system as a basis for prospective reimbursement for Medicare patients, it provided a measure of resource utilization which was comparable with US data. Each separation from a hospital for the study year (1984/85) was assigned a DRG-based weight. The resource utilization was estimated by a weighted sum of the separations. The weights used were those used by the Health Care Financing Administration, the U.S. Department of Health and Human Services. Further, the average cost per unit of DRG weight experienced by all Alberta hospitals in 1984/85 was used to estimate the cost for each DRG category.

Although there are controversies surrounding case mix homogeneity within each DRG category (Horn & Sharkey, 1983; Horn, Sharkey & Bertram, 1983; Johnson & Appel, 1984; May & Wasserman, 1984), it appeared that the DRG classification system provided the best case mix measure at the moment. Some advocate incorporation of case severity for case mix measures (Horn & Sharkey, 1983; Horn, Sharkey & Bertram, 1983); however, the lack of a case severity measure which is solely based on hard data precluded such an application.

2) Complicated computational procedures was the second difficulty associated with the original model. This was remedied by the development of a micro computer based user-friendly system. The system took advantage of current development in micro technology.

3) Lastly, the most recent PAS data available were used (1984/85).

3.1.1 General Procedures

(1) The patient separation files were converted into a number of

hospital by GHD data matrices whose elements represented the total number of SEP, PDAY, and USWE.

(2) These files and other hospital or district specific information such as number of beds, service populations, and operating support were then downloaded (transferred) to a micro computer system.

(3) Using LOTUS 1-2-3 and SPSS/PC, the files were analyzed to derive population based hospital and GHD resource utilization and allocation measures such as USWERATE, ALOS, BDI and SPI (Bay and Nestman, 1984). The analytic sequence that was followed in this study is delineated in Figure 1.

3.2 Data Sources

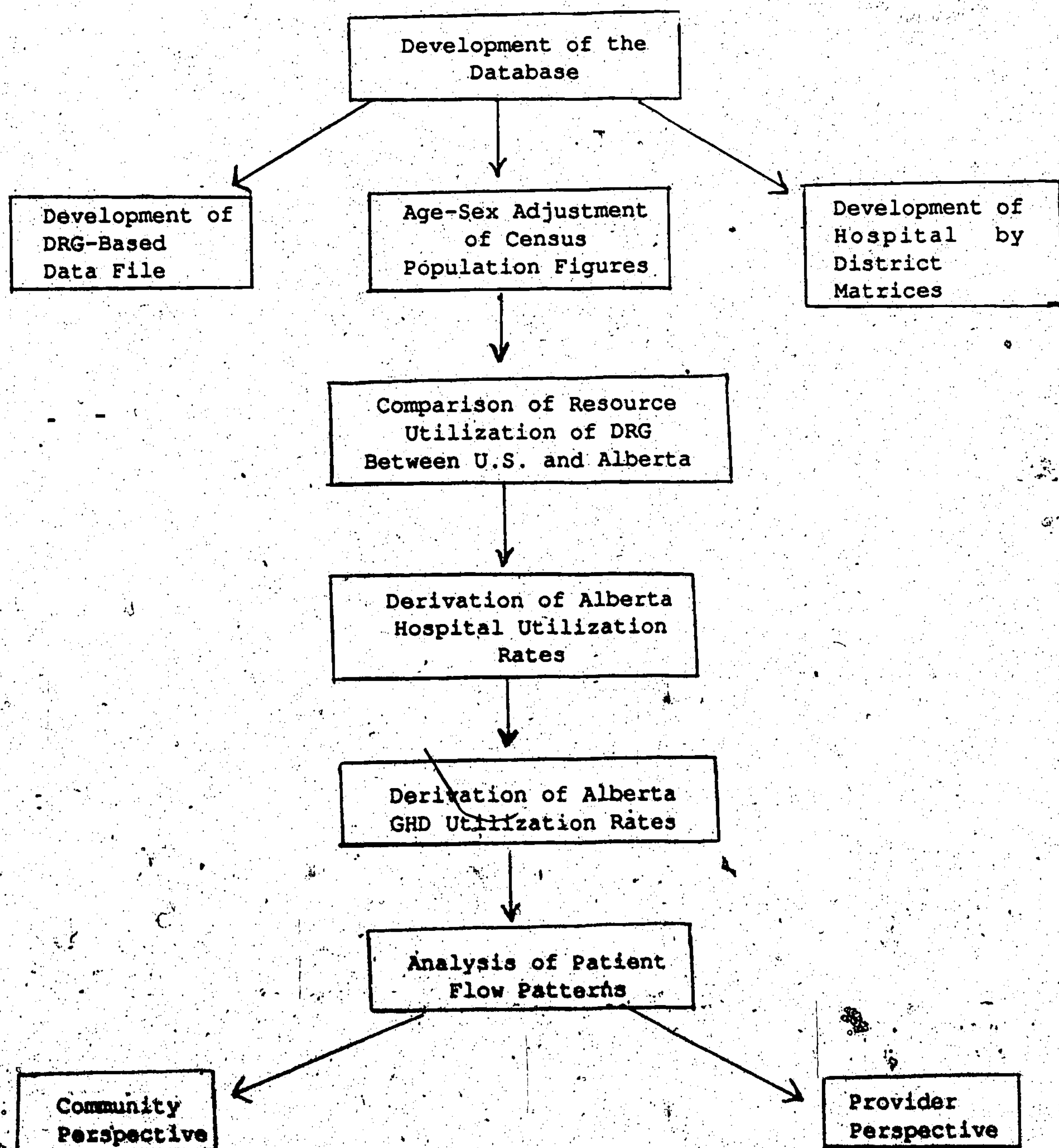
The data necessary for the research were obtained primarily from four sources: (a) Professional Activity Study (PAS) hospital separation abstracts; (b) Statistics Canada census figures; (c) Provincial Government annual reports; and (d) the U.S. Reimbursement Schedule.

3.2.1 PAS Abstracts

The calculation of utilization rates requires accurate measures of utilization for the numerator. Hospital separation abstracts which are routinely collected and summarized for each hospital in Alberta by the Commission on Professional and Hospital Activities (CPHA) in Ann Arbor, Michigan are a useful source of such utilization measures. For this study, PAS abstracts (the compiled form of the utilization measures) for Alberta residents separated from acute care hospitals for the fiscal year 1984/85 were utilized.

Figure 1

Analytic Sequence of Research Methodology



The PAS abstracts were obtained from provincial government computer tapes. Variables of particular relevance to this research included: (a) age of patient on admission; (b) sex of the patient; (c) length of stay; (d) DRG codes; (e) code of the admitting hospital; and (f) hospital district corresponding to the patient's residence.

Some caution must be exercised when the hospital separation abstract is the basis upon which the interpretations are made. A separation abstract is required for every patient admitted to a hospital. Consequently, the actual incidence of disease may be overestimated owing to the fact that people are often readmitted with the same diagnosis or transferred to a more appropriate health care facility. To partially alleviate this problem, the data analysis also incorporated patient days (PDAY) and weighted separations (USWE). While the use of the PDAY is a more accurate measure than SEP in terms of resources used, there is the potential for bias to occur owing to the fact that the separation is coded to the year in which the separation occurred, regardless of the year of admission. However, it was assumed that this limitation is minimal since potential distortions occur at both the beginning and the end of each year, resulting in a cancelling-out effect. By using DRG weighted separations (USWE), the variation in resource requirement due to case mix differences among hospitals was recognized.

3.2.1.1 Geographic Unit of Analysis

To facilitate comparisons of utilization rates across geographic districts and examine patient flow patterns, the province was divided into mutually exclusive and exhaustive geographic units. Utilization studies done previously considered the hospital district to be the most approporate geographic classification unit for the following reasons: (1) the size of the hospital district facilitates the reduction of data volume and at the same time does not conceal significant differences in utilization patterns; (2) PAS separation abstracts record the hospital district as the patients' origin; (3) census enumeration areas (EA) do not cross political boundaries, thus enabling tabulation of census data according to GHD; (4) of the 102 hospital districts in Alberta, the majority include only one hospital.

3.2.2 Census Data

The calculation of per-capita utilization rates requires accurate measurement of the denominator which represents the number of potential users in the geographic unit. Statistics Canada provided census data, according to enumeration areas (EA) for the year 1981. The Department of Hospitals and Medical Care (DHMC) tabulated these data into five-year age groups, sex, and general hospital district. To make the comparisons of per capita resource allocation or utilization rates meaningful, an adjustment of the age-sex disparity among districts was made. Two methods may be used to achieve age-sex adjustment - the direct and the indirect methods. The indirect method was chosen owing to its less complex mathematical manipulations; in addition, the indirect method applies the more stable rates of the larger population to the smaller district populations. The weighted-sum approach as in Bay and Nestman (1980, 1984), in conjunction with age-specific per capita USWE values were applied to 1981 census population figures resulting in service populations for each GHD.

3.2.3 Provincial Government Annual Reports

Annual reports and statistical supplements issued by the DHMC provided necessary data such as the number of acute care hospitals and the approved bed complement, operating budget and actual expenditures of each acute care hospital.

3.2.4 U.S. Reimbursement Schedule

The Prospective Payment Assessment Commission provided the U.S. reimbursement schedule which enabled the author to obtain data on each DRG category including the 1986/87 weight, and average cost, number of separations, and average length of stay in terms of the geometric mean [illegible]e year 1984/85.

[illegible]alysis Strategies

[illegible] analysis of resource allocation and utilization measures in [illegible] was conducted in four steps: (1) provincial case mix analysis; (2) hospital analysis; (3) district analysis; and (4) patient flow pattern analysis. These four phases are outlined in the following sections.

3.3.1 Provincial Case Mix Analysis

To provide an overall perspective of case mix complexity, AUSWE was computed by dividing USWE (DRGW-separations) for Alberta as a whole by the total number of separations (SEP). The AUSWE was similarly calculated for the U.S. which facilitated a comparison between the two populations. To determine where resources were allocated and consumed, the top forty DRGs were ranked according to USWE for both Alberta and the United States; thus, comparisons were made with respect to which DRGs consumed a large percentage of hospital resources.

Owing to different health care systems in the United States and Alberta, it was recognized that while Alberta data were based on the total provincial population, the U.S. data consisted of primarily those 65 years and over (Medicare) and some of low income status (Medicaid). Thus, to make the two data sets more comparable, those DRGs not applicable to persons 65 years of age and over were excluded from the U.S. data and persons under 65 years of age were excluded from the Alberta data. Analyses similar to the latter investigation were conducted.

3.3.2 Hospital Analysis

To achieve interhospital comparisons, data analyses involved the calculation of both per case and per capita utilization rates for each general hospital in Alberta for the fiscal year 1984/85 (see Appendix C.1 for hospital codes and names). Per case rates differ from per capita rates in that the former disregard the population served. Three factors were considered to influence hospital performance - size, level of care, and location; these factors were subsequently used for hospital classification and analyses purposes (see Appendix C.2 for hospital groupings). Hospital-specific utilization measures were analyzed which involved per case rates only such as ALOS (average length of stay) and AUSWE (case mix complexity). The numerators and denominators were calculated by aggregating the utilization data over the appropriate classification group. Population-based hospital measures were also examined by calculating per capita rates such as SPI (Service Population Index) and USWERATE (number of weighted separations per capita). The denominators used in the per capita rate calculations were the age-sex adjusted 1981 census populations.

3.3.3 **District Analysis**

The focus of this analysis was the effect of case mix (AUSWE) and geographic factors on resource utilization. Per case rates (ALOS, AUSWE) and per capita rates (BDI, USWERATE) were calculated for each GHD in Alberta for 1984/85 (see Appendix C.3 for district codes and names). To provide a broad perspective of resource utilization across GHDs, the minimum and maximum for each rate were examined as well as the first, second and third quartiles. The numerators for both the per case and the per capita rates were calculated by aggregating the utilization data over all districts in the province. Age-sex adjusted 1981 census populations were used in the denominators for the per capita rates. Geographic variation was explored by classifying GHDs in two ways: (1) into seven mutually exclusive and exhaustive provincial regions; and (2) into 3 areas of varying urbanization - metropolitan, suburban, and rural (see Appendix C.4 for district groupings).

3.3.4 Analysis of Patient Flow Patterns

The analysis of patient care-seeking behavior provided information from both a community perspective and a hospital (or provider) perspective. While information from the community perspective was primarily directed toward provincial-wide planning, information gained from the provider perspective was intended to enhance resource allocation and planning endeavors within a particular district or region. Using a computer program based on the Statistical Package for the Social Sciences (SPSSX), patient origin-destination matrices were constructed whereby the patient's residence and the hospital of service delivery served as the patient origin variable and the patient destination variable, respectively. The cross tabulated matrices were based on SEP, PDAY and USWE as measures of resource utilization. The patient flow measures determined from the matrices included relevance indices (which measured the likelihood of patients to use a particular hospital or group of hospitals) and commitment indices (which measured the likelihood of a specific hospital to commit resources to patients from specific geographic areas). Relevance and commitment indices were presented according to level of hospital care available and district location in terms of urbanization and regional divisions (see Appendices C.2 and C.4 for hospital and district groupings).

3.4 Chapter Summary

The methodology used to examine the application of a DRG-based service population model in Alberta was presented in three sections. First, a general research strategy was formulated based on the hospital service population model previously developed by Bay and Nestman (1980, 1984). Second, the sources of data necessary for the study were identified. In the final section, four data analysis strategies were outlined and included: (1) examination of case-mix complexity in the U.S. and Alberta; (2) analysis of hospital utilization; (3) district analysis; and (4) delineation of patient flow patterns.

CHAPTER IV

RESULTS

The research findings of this investigation are presented in five sections: (1) provincial overview; (2) case mix analysis; (3) hospital analysis; (4) district analysis; and (5) analysis of patient flow patterns.

4.1 Provincial Profile

The purpose of this section is to provide the reader with demographic and geographic characteristics of the province as well as some features of Alberta's health care system which could influence the utilization of services and the behavior patterns of individuals seeking hospital care. The review will include structural aspects such as hospitals and general hospital districts (GHDs) as well as system variables such as census and service populations. Pertinent utilization and economic statistics for the fiscal year 1984/85 will also be reviewed.

4.1.1 Alberta

The province of Alberta is one of Canada's three prairie provinces. Population growth in Alberta was slowest during the Great Depression of the 1930s but the rate increased after World War II through immigration from overseas and the movement of people from other parts of Canada to Alberta. From 1973 to 1983 the province experienced its most rapid growth; however, the population declined from 2,367,400 in 1983 to 2,341,600 in 1984. It has slowly increased from 1984 with a population of 2,357,100 and 2,365,825 in 1985 and 1986 respectively.

Alberta's population was classified as 79.4% urban and 20.6% rural in 1986. Rural population reached its peak in the late 1930s, with 530,000 people accounting for two-thirds of the provincial total. However, urbanization quickened during WW II and sharply accelerated in the postwar boom years. The most notable feature of urban growth is its concentration in two metropolitan centers: Edmonton and Calgary. In 1986, the population of these two centers accounted for over 60% of the total provincial population. Calgary's hinterland includes all of the province south of Red Deer while Edmonton's hinterland includes everything north of Red Deer. Lethbridge and Medicine Hat are defined as secondary urban centers in the south while Fort McMurray in the northeast and Grande Prairie in the northwest may be regarded as the secondary urban centers of the north. Red Deer may be regarded as the urban center shared between the north and the south. St. Albert, Sherwood Park, Leduc and Ft. Saskatchewan are virtually satellite towns of Edmonton and are normally included in metro Edmonton.

There are a variety of health care institutions in the province including large general hospitals in the major urban centers, smaller rural hospitals, auxiliary hospitals specializing in extended care treatment, nursing homes for senior citizens and provincial mental and psychiatric hospitals. The people who occupy the rural and far northern parts of the province have access to the local hospitals; one is located in almost every hospital district. However, for specialized care, most patients travel into one of the two metropolitan centers - Edmonton for those living in the north and Calgary for those in the southern part of the province.

4.1.2 Alberta Hospitals and Districts

The Department of Hospitals and Medical Care (DHMC) is responsible for the planning, construction and operation of all active treatment, auxiliary, and mental hospitals in Alberta. In addition, the DHMC is responsible for monitoring the activities within these health institutions and ensuring that funds are expended effectively and that legislation is endured.

Federal, provincial or municipal governments own and operate the majority of the general hospitals in Alberta. Non-governmental ownership belongs to groups such as religious orders or voluntary organizations. No general hospitals are privately owned and operated for profit. The governing authority for all general hospitals (except the federally owned institutions) is the hospital board which has the legislated authority and responsibility for the operation and management of the hospital. In addition, the board is responsible for the expenditure of alloted funds and the financial stability of the hospital. In Alberta, general hospitals are relatively evenly distributed among hospital districts with usually one facility in each district. There are, however, nine districts with more than one hospital.

In the fiscal year 1984/85, there were 124 active treatment hospitals operating in Alberta with an approved bed complement of 12,245 adult and paediatric beds. Despite hospitals being relatively evenly distributed among the districts, the same can not be said about the distribution of hospital beds in the province. For the year ended March 31, 1985, twelve hospitals (300 beds and over) accounted for 54% of all active treatment beds. For Alberta as a whole, in 1984/85 there were 5.4 rated beds per 1000 persons.

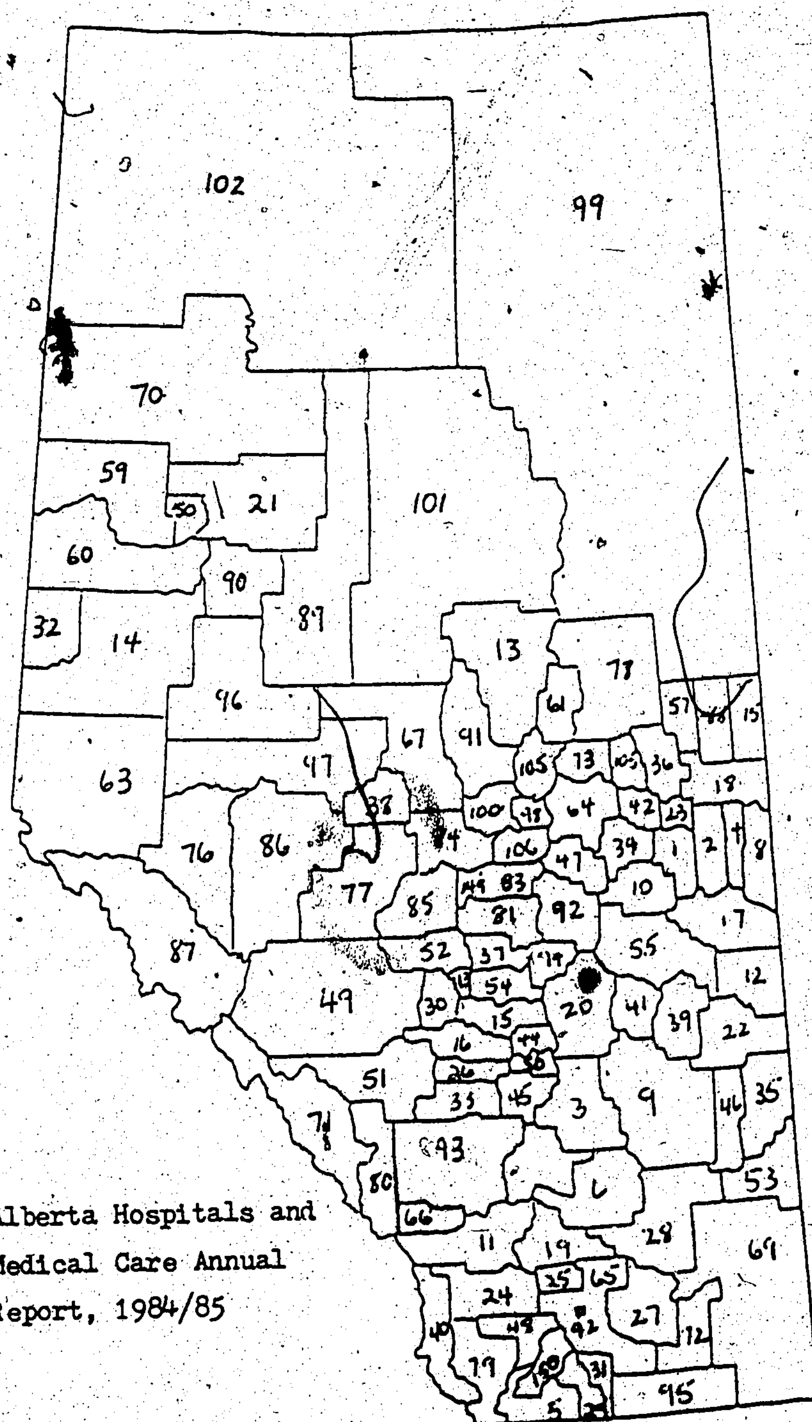
Currently, the province of Alberta is divided into 102 mutually exclusive and exhaustive general hospital districts (GHDs). Albertans are free to cross these district boundaries and seek care in a hospital outside of the district in which they reside. These districts vary significantly with respect to geography, demography, climate and type, size and location of hospital. The northern districts tend to have large areas with sparse populations while those districts in the southern-central part of the province envelop comparatively smaller areas but have higher population densities (Figure 2). The variability in the distribution of population and geographic size among hospital districts may influence the utilization of hospital services owing to dissimilar distance and time factors among districts which have been shown to have an impact on the behavior patterns of individuals seeking hospital care. In addition, the differences in population densities may have an impact on the type, number and location of health care resources which, subsequently, may influence individuals' behavior patterns.

4.1.3 Census Data and Service Populations

As of June 1, 1984, there were 2,341,600 residents in Alberta and as of June 1, 1985, there were 2,357,100 residents residing in the

Figure 2

General Hospital Districts



Source: Alberta Hospitals and Medical Care Annual Report, 1984/85 province with approximately one-third falling into the 25-44 age group in each year (Table 1). Canada had, overall, a similar age distribution as Alberta; however, smaller percentages were found in the two oldest age groups in Alberta indicating a slightly younger population in Alberta as compared to Canada as a whole.

In any evaluation of resource allocation and consumption an adjustment of age-sex disparity among districts must be made so that per capita resource allocation or utilization may be meaningful. Adjustment of crude population figures results in service populations - the age-sex adjusted number of residents in each district. Various utilization measures may be used (separations or patient days) to derive weighting factors for the adjustment. However, for this study, age-sex specific per capita USWE (United States Weight Equivalent) were used which estimate relative resource requirements per person in each age-sex group. Because the effects of case mix variation on resource needs were taken into account, per capita USWE (rather than separations or patient days) more accurately described age-sex specific average resource requirements.

It is assumed that there is more resource variation between DRG groups than within DRG groups. Incorporating the weighted-sum approach (Bay and Nestman, 1980), the age-sex specific per capita USWE were applied to 1981 crude population figures resulting in service populations for each general hospital district (GHD). As a result, the hospital districts with relatively higher proportions of elderly residents were assigned inflated service populations as compared with the census populations; thus, a ratio greater than 1.0 was obtained.

Table 1

Population Figures for Alberta and Canada for 1984 and 1985

Age Group (Years)	Alberta[1] 1984 (%)	Alberta[1] 1985 (%)	Canada[1] 1984 (%)	Canada[1] 1985 (%)
0-14	562.0 (24.0)	567.8 (24.1)	5460.2 (21.7)	5453.9 (21.5)
15-24	440.4 (18.8)	419.6 (17.8)	4455.1 (17.7)	4367.8 (17.2)
25-44	788.9 (33.7)	801.3 (34.0)	7832.5 (31.2)	8036.7 (31.7)
45-64	370.5 (15.8)	381.2 (16.2)	4823.7 (19.2)	4859.1 (19.2)
65+	179.8 (7.7)	187.2 (7.9)	2556.5 (10.2)	2641.2 (10.4)
TOTAL	2341.6 (100)	2357.1 (100)	25128.0 (100)	25358.7 (100)

Reference: CANSIM STATISTICS CANADA, MATRIX No. 000060, Series D14 and D23 in Statistics Canada Cat No 91-210, April 1985.

[1] population figures in thousands

Conversely, those districts with relatively younger residents produced a ratio less than 1.0. Table 2 indicates the magnitude of this adjustment for selected GHDs. Most of the districts deviated substantially from 1.0 (average of 11.6%) suggesting the importance of adjusting the crude population figures.

4.1.4 General Utilization and Economic Statistics

The Alberta population in 1981 was 2,237,270 and acted as the denominator for calculating SEPRATE and PDAYRATE. The unavailability of 1986 census data tabulated by sex, age, and GHD precluded its use in the denominator. The total number of separations was 437,620 resulting in a SEPRATE (number of separations per capita - year) of 0.195. As a whole, 2,953,493 patient days were generated by the Alberta general hospitals for the year 1984/85 resulting in a PDAYRATE (number of patient days per capita - year) of 1.3. The number of patient days per separation was also calculated and resulted in an average length of stay (ALOS) in hospital of 6.75 days.

Regardless of ownership type, most of the hospital and capital expenditures are covered by the provincial government. The federal government provides support through transfer payments under the Established Programs Financing (EPF) Act although, in 1986, the federal government introduced amendments to this act which could lessen this support drastically. Currently, Alberta hospitals are administered, financially, on the basis of global budgeting principles. Alternative systems have been examined, however, for the purpose of cost containment. A volume-driven system was implemented on a trial basis in

Table 2

Ratios of Service Population to Census Population for Selected GHDs

General Hospital District	Ratio	Census Population	Service Population
Smoky Lake	1.35	3295	4454
Myrnam	1.34	1205	1612
Vegreville	1.26	8015	10088
Picture Butte	1.28	1415	1805
Grande Cache	0.78	4775	3710
Ft. McMurray	0.79	33300	26204
Cold Lake	0.85	12485	10609
Hinton	0.84	9050	7568

three Alberta hospitals from 1983 to 1986. The DRG-based reimbursement system currently used in the United States is another alternative method of financing considered. Though Alberta hospitals maintain DRG codes on patient separation abstracts, the classification system is not currently used for reimbursement purposes.

Total Alberta health care expenditures amounted to 2,478 million dollars in 1984 and 2,476 million dollars in 1985 (total expenditures include hospitals, medicare, departmental support and occupational health services and capital expenditures and research costs). Hospital expenditures accounted for approximately 70% of the total expenditures for both 1984 and 1985. On a per capita basis, hospital expenditures amounted to 729.02 dollars in 1984 decreasing slightly to 721.11 dollars per capita in 1985. Corresponding total health expenditures were 1,054.75 dollars per capita in 1984 and 1,050.10 dollars per capita in 1985. For 1985, total health care expenditures amounted to 6.4% of the provincial GDP (Gross Domestic Product) with hospital costs amounting to 2.5% of the GDP. Relevant to this study, 70.6% of hospital expenditures were attributed to active care in 1984 rising to 72.8% in 1985.

4.1.5 Summary

The previous section disclosed several aspects of Alberta and its health care system:

(1) The population of Alberta largely resides in the urban centers with 79.4% classified as urban and 20.6% classified as rural in 1986.

(2) Urbanization sharply accelerated in the postwar boom years and is concentrated in two metropolitan centers: Edmonton and Calgary.

(3) The Provincial Government, through the DHMC, approves the planning, construction, and operation of all active treatment and auxiliary hospitals in Alberta.

(4) In 1984/85, 124 general hospitals were operating in Alberta with an approved bed complement of 12,245 beds resulting in 5.4 rated beds per 1,000 persons.

(5) The province of Alberta is divided into 102 mutually exclusive and exhaustive general hospital districts (GHDs) differentiated by geography, demography, climate and type, size, and location of hospital.

(6) As of June 1, 1984, there were 2,341,600 Alberta residents and there were 2,357,100 residents as of June 1, 1985. When compared with Canadian population figures, it was apparent that Alberta had a slightly younger population.

(7) The crude population figures for each hospital district were age-sex adjusted by applying provincial age-specific per capita DRG weighting factors.

(8) For the province of Alberta, the SEPRATE was 0.195 per capita; the PDAYRATE was 1.3 per capita and the ALOS was 6.75 days.

(9) Total health care expenditures amounted to approximately 2.5 billion dollars in both 1984 and 1985 with hospital costs accounting for about 70% of these expenditures in both years.

(10) Per capital hospital expenditures were $729.02 and $721.11 in 1984 and 1985 respectively.

(11) Total health care expenditures amounted to 6.4% of the provincial GDP while hospital costs amounted to 2.5%.

4.2 Case Mix Analysis

As the type and level of services required are largely dependent on the patients' disease/disability type and level of care needs, case mix is an important determinant of the quantity and type of resources necessary for the treatment of patients. Generally, the more complex cases included in the case mix, the more resources needed. Though two hospitals may be relatively similar with respect to the number of separations, one hospital may be more resource intense owing to the complex cases it treats. This section is designed to analyze relevant information regarding the case mix of Alberta as measured by DRGs; as well, comparisons will be made with the U.S. case mix.

4.2.1 Case Mix of Alberta Hospitals

Both patient-days (PDAY) and number of separations (SEP) may be used for utilization measures. However, neither of these measures take into account the disparity in resource consumption among various disease categories. The DRG classification system made available another measure of resource use which recognizes the variation in resource consumption for different separation categories. For this study, the DRG specific relative resource requirements are indicated as **DRGW** (Diagnosis Related Group Weight). The DRG classification system was developed in such a way that the resources consumed by patients within a DRG group are as similar as possible but different across DRG groupings. Although there are severe criticisms about DRGs for prospectively specifying resource requirements, and the writer agrees that the classification scheme is far from ideal, the assumption was made that the DRG classification and weights measure relative average resource requirements similarly in Canadian and American hospitals.

With respect to the DRGW, it is a relative measure which represents the average resource requirement for cases in a particular DRG group relative to national average resources consumed by all U.S. separations. Therefore, a separation which has a DRGW of 2.0 requires, on average, twice the resources that the average U.S. hospital separation case requires. Thus, the total number of separations generated in Alberta in 1984/85, weighted by the appropriate DRGW values, would approximate, in relative terms, the utilization and/or resource needs in Alberta active treatment hospitals.

The latter calculation, the sum of separations weighted by the appropriate DRGW values, resulted in the USWE (United States Weight Equivalent). The average USWE (AUSWE) was calculated by dividing the USWE, for Alberta as a whole, in 1984/85 by the total number of SEP and was an indicator of case mix complexity. An AUSWE above 1.0 was indicative of a relatively high case mix complexity as compared with the U.S.; conversely, a ratio of less than 1.0 was indicative of a relatively low case mix complexity. Consequently, the DRGW was incorporated into this study to control the variation in resource requirement between hospitals in Alberta owing to case mix differences. As the medical practice and hospital payment methods are different between the U.S. and Alberta, this measure was used only as a "relative" measure of resource needs and was not used in the absolute sense.

An estimation of the cost of hospital resources consumed by each separation in Alberta in 1984/85 was also determined. From government data, the total cost of hospital care (excluding long term care) was determined. A cost per USWE unit was calculated for all Alberta cases and subsequently multiplied by the USWE resulting in the Alberta dollar cost for any subgroup of patients.

For the province of Alberta, in 1984/85, the AUSWE (Average United States Equivalent) was 0.77 which indicated that Alberta general hospitals treated a case mix of much below average complexity as compared with U.S. hospitals (theoretical average in U.S. equals 1.0). To determine where hospital resources were being consumed, the top forty DRG codes were ranked according to USWE (Table 3). Approximately, 41% of hospital resources were consumed by less than one-tenth of all DRG groups representing about 44% of separations and 45% of patient-days. Estimated cost for the top forty DRGs totalled approximately 463.4 million dollars.

To provide a broader picture of resource utilization, USWE was broken down by MDCs (Table 4). Appendix A.1 outlines the 23 MDCs. Thirty-three percent of total resources were accounted for by three MDCs: MDC 6 (Diseases and Disorders of the Digestive System), MDC 8 (Diseases and Disorders of the Musculo-skeletal System and Connective Tissue), and MDC 5 (Diseases and Disorders of the Circulatory System) representing approximately 28% of the total separations.

4.2.2 Case Mix Comparison - Alberta and United States

In Canada, residents are covered by national health insurance standards with each provincial government operating a provincial health insurance plan. Almost all Albertans are covered by hospital and

TABLE 3

DRG Codes Ranked According to Resource Consumption (USWE): Alberta and United States

USWE Rank	DRG	Description	DRGW	USWE*	USWE%	SEP*	SEP%	SEP Rank	PDAY*	PDAY%	PDAY Rank	Estimate Cost ($M)	GMLOS
		<===Alberta===>											
1	373	Vag Deliv w/o Comp Diag	0.35	10.22	3.03	28.99	6.62	1	126.78	4.29	1	33.9	4.1
2	468	Unrelated O.R. Proc	2.45	8.86	2.63	3.62	0.83	22	51.80	1.75	5	29.4	8.0
3	98	Bronch + Asthma 0-17	0.72	5.77	1.71	8.02	1.83	5	36.88	1.25	12	19.2	3.6
4	390	Neon w Oth Sig Problems	0.35	5.27	1.56	15.13	3.46	3	66.30	2.24	4	17.5	4.1
5	243	Medic Back Problems	0.68	4.57	1.35	6.68	1.53	8	49.69	1.68	6	15.2	5.0
6	371	Cesarean Sec w/o CC	0.77	4.48	1.33	5.84	1.33	10	41.68	1.41	8	14.9	6.6
7	183	Eso, Gas + Misc Dig 18-69	0.51	4.39	1.30	8.60	1.97	4	34.11	1.15	17	14.6	2.8
8	430	Psychoses	1.08	4.36	1.29	4.06	0.93	17	78.13	2.65	3	14.5	11.5
9	355	Non-rad Hyst, <70 w/o CC	1.04	4.26	1.26	4.12	0.94	16	31.23	1.06	19	14.2	7.3
10	391	Normal Newborns	0.22	4.25	1.26	19.17	4.38	2	80.99	2.74	2	14.1	4.0
11	209	Major Jnt + Limb Reat	2.39	3.93	1.16	1.64	0.38	63	34.89	1.18	16	13.1	18.0
12	184	Eso, Gas + Misc Dig, 0-17	0.48	3.80	1.13	7.88	1.80	6	30.29	1.03	20	12.6	2.8
13	127	Heart Failure + Shock	1.01	3.67	1.09	3.63	0.83	21	47.20	1.60	7	12.2	8.4
14	182	Eso, Gas + Misc Dig >69 a/o CC	0.60	3.45	1.02	5.73	1.31	11	40.63	1.38	9	11.5	4.8
15	88	Chron Obstruc Pulmon Dis	1.08	3.41	1.01	3.17	0.72	26	37.26	1.26	11	11.3	7.9
16	467	Other Fac Infl Health Status	0.72	3.41	1.01	4.72	1.08	14	31.84	1.08	18	11.3	3.2
17	389	Full Term Neon w Maj Problems	0.54	3.36	1.00	6.19	1.42	9	35.60	1.21	14	11.2	5.1
18	148	MajSm+LgBowel Proc, >69 a/o CC	2.94	3.21	0.95	1.09	0.25	95	24.94	0.84	24	10.7	18.7
19	122	Cir Disord w AMI w/o CV, Alive	1.33	3.09	0.91	2.33	0.53	41	26.66	0.90	22	10.3	8.8
20	197	Tot Chol w/o CDE, >69 a/o CC	1.71	3.06	0.91	1.80	0.41	52	20.03	0.68	29	10.2	9.8
21	91	Simp Pneu + Pleur, 0-17	0.79	3.02	0.90	3.82	0,87	18	25.58	0.87	23	10.0	5.1
22	70	Otitis Media + URI, 0-17	0.53	2.99	0.88	5.69	1.30	12	23.10	0.78	27	9.9	3.1
23	198	Tot Chol w/o CDE, <70 w/o CC	1.14	2.90	0.86	2.54	0.58	36	19.69	0.67	31	9.6	7.3
24	154	Sto, Eso + Duo Proc, >69 a/o CC	2.69	2.88	0.85	1.07	0.24	96	19.99	0.68	30	9.5	13.1
25	358	Uter + Adn Proc NM, >69	1.12	2.78	0.82	2.50	0.57	38	14.03	0.48	44	9.2	4.7
26	14	Spec CerVas Disor X TIA	1.31	2.77	0.82	2.11	0.48	46	39.86	1.35	10	9.2	9.8
27	89	Simp Pneu + Pleur, >69 a/o CC	1.17	2.67	0.79	2.29	0.52	42	27.40	0.93	21	8.9	8.5
28	294	Diabetes >35	0.75	2.50	0.74	3.35	0.77	24	35.24	1.19	15	8.3	7.6
29	215	Back + Neck Proc, <70 w/o CC	1.43	2.50	0.74	1.75	0.40	57	19.09	0.65	32	8.3	9.3
30	381	Abor w DC, Asp Cur or Hys	0.37	2.49	0.74	6.68	1.53	7	10.15	0.34	67	8.3	1.3
31	426	Depress Neuroses	0.83	2.46	0.73	2.96	0.68	29	36.57	1.24	13	8.2	7.4
32	167	App w/o Com Pri Diag, <70 w/oCC	0.89	2.44	0.72	2.75	0.63	31	12.01	0.41	60	8.1	4.1
33	222	Knee Proc, <70 w/o CC	0.73	2.33	0.69	3.21	0.73	25	13.16	0.45	50	7.7	3.5
34	372	Vag Deliv w Comp Diag	0.59	2.21	0.66	3.78	0.85	20	21.89	0.74	28	7.4	5.0
35	108	Oth Car Thor Proc w Pump	4.78	2.18	0.64	0.46	0.10	220	3.05	0.10	227	7.2	4.5
36	97	Bronch + Asthma, 18-69 w/o CC	0.71	1.97	0.58	2.78	0.63	30	14.34	0.49	40	6.5	4.0
37	75	Maj Chest Proc	2.98	1.94	0.57	0.65	0.15	159	12.87	0.44	52	6.4	15.6
38	82	Resp Neoplasms	1.13	1.91	0.56	1.69	0.39	60	23.97	0.81	26	6.3	8.2
39	110	Maj Rec Vas Proc w/o Pump, >69	3.31	1.89	0.56	0.57	0.13	186	11.36	0.38	64	6.3	15.4
40	210	Hip + Fem X Maj Jnt, >69 a/oCC	2.03	1.88	0.56	0.93	0.21	114	24.56	0.83	25	6.3	19.3
TOTAL				139.53	41.32	193.93	44.31		1334.86	45.20		463.3	

* in thousands

TABLE 3 (continued)

USWE Rank	DRG	Description	DRGW	USWE*	USWE%	SEP*	SEP%	SEP Rank	GMLOS
		<==========United States==========>							
1	127	Heart Failure and Shock	1.01	505.57	4.25	500.67	4.64	1	6.8
2	14	Spec CerVas Disor X TIA	1.31	404.06	3.40	307.44	2.85	5	8.5
3	468	Unrelated O.R. Proc	2.45	395.80	3.33	161.45	1.50	13	11.7
4	89	Simp Pneu + Pleur, >69 a/o CC	1.17	353.53	2.97	303.28	2.81	6	7.5
5	209	Major Jnt + Limb Reat	2.39	338.46	2.85	141.47	1.31	16	14.4
6	148	MajSm+LgBowel Proc, >69 a/o CC	2.94	305.38	2.57	103.87	0.96	24	15.3
7	88	Chron Obstruc Pulmon Dis	1.08	239.64	2.02	222.55	2.06	7	6.6
8	39	Lens Proc w/wo Vitrectomy	0.57	235.86	1.98	412.41	3.82	2	2.1
9	210	Hip + Fem X Maj Jnt, >69 a/oCC	2.03	235.82	1.98	116.07	1.08	22	14.6
10	182	Eso, Gas + Misc Dig >69 a/o CC	0.60	230.71	1.94	382.48	3.54	3	4.8
11	122	Cir Disord w AMI w/o CV, Alive	1.33	215.77	1.81	162.63	1.51	12	8.8
12	140	Angina Pectoris	0.69	214.19	1.80	310.69	2.88	4	4.6
13	107	Coron Byoass w/o Car Cath	4.66	191.06	1.61	40.99	0.38	66	12.7
14	110	Maj Rec Jas Proc w/o Pump, >69	3.31	177.14	1.49	53.49	0.50	49	13.1
15	138	Car Arr + Cond Dis, >69 a/o CC	0.81	167.10	1.41	205.39	1.90	9	4.9
16	121	Cir Disor w AMI + CV, Alive	1.77	166.99	1.40	94.42	0.87	26	10.3
17	116	Perm Car Pace Imp w/o A,HF,S	2.99	154.85	1.30	51.84	0.48	53	7.8
18	87	Pulmon Edema + Resp Fail	1.81	150.29	1.26	83.15	0.77	30	7.0
19	96	Bronch + Asthma, >69 a/o CC	0.84	146.56	1.23	173.53	1.61	10	6.0
20	154	Sto,Eso + Duo Proc, >69 a/o CC	2.69	142.62	1.20	53.07	0.49	50	11.5
21	243	Medic Back Problems	0.68	141.16	1.19	206.38	1.91	8	6.2
22	82	Resp Neoplasms	1.13	141.15	1.19	125.37	1.16	20	6.6
23	336	Transureth Pros, >69 a/o CC	0.99	139.83	1.18	141.69	1.31	15	7.0
24	296	Nut + Misc Met Dis, >69 a/o CC	0.83	132.59	1.11	160.30	1.49	14	6.1
25	174	GI Hemor, >69 a/o CC	0.91	123.51	1.04	136.13	1.26	18	5.8
26	197	Tot Chol w/o CDE, >69 a/o CC	1.71	121.41	1.02	71.19	0.66	36	10.5
27	320	Kid + Uri Trc Inf, >69 a/o CC	0.86	118.15	0.99	136.97	1.27	17	6.5
28	15	Tran Isch Attack + Prec Occl	0.62	107.90	0.91	172.88	1.60	11	4.7
29	132	Atherscler, >69 a/o CC	0.80	99.27	0.83	123.52	1.14	21	5.3
30	112	Vasc Proc X Maj Rec w/o Pump	2.21	97.29	0.82	44.11	0.41	60	8.1
31	416	Septecemia >17	1.62	96.76	0.81	59.80	0.55	39	8.3
32	106	Coron Bypass w Card Cath	5.33	96.27	0.81	18.05	0.17	120	14.7
33	294	Diabetes, >35	0.75	95.29	0.80	127.84	1.18	19	6.7
34	430	Psychoses	1.08	92.15	0.77	85.64	0.79	28	10.5
35	123	Cir Disor w AMI, Expired	1.35	91.72	0.77	67.83	0.63	37	3.0
36	5	Extracran Vasc Proc	1.65	89.60	0.75	54.28	0.50	46	8.0
37	79	Res Infec + Inflam, >69 a/o CC	1.93	86.96	0.73	44.95	0.42	57	9.6
38	75	Maj Chest Proc	2.98	81.13	0.68	27.25	0.25	91	13.4
39	130	Perip Vasc Dis, >69 a/o CC	0.83	80.61	0.68	97.70	0.91	25	5.7
40	403	Lymph/Leuk,>69 a/o CC	1.35	73.46	0.62	54.44	0.50	45	7.4
TOTAL				7077.61	59.52	5837.18	54.08		

* in thousands

TABLE 4

Resource Consumption According to MDCs:
Alberta and U.S., 1984/85

	<=====Alberta=====>						<=====United States=====>					
MDC	SEPS	SEPS%	SEPSR	USWE	USWE%	USWER	SEPS	SEPS%	SEPSR	USWE	USWE%	USWER
1	17954	4.10	9	16552.62	4.90	8	896227	8.30	5	983098.79	8.27	5
2	7515	1.72	16	3901.81	1.16	21	513212	4.75	7	293030.22	2.46	11
3	27139	6.20	7	12769.75	3.78	10	178150	1.65	15	114422.76	0.96	18
4	31154	7.12	5	29108.00	8.62	4	1228360	11.38	3	1455626.62	12.24	2
5	29463	6.73	6	34650.23	10.27	3	2419630	22.42	1	3006583.58	25.28	1
6	52145	11.92	2	41932.24	12.42	1	1363201	12.63	2	1438126.77	12.09	3
7	10201	2.33	13	13495.92	4.00	9	321252	2.98	10	445887.60	3.75	7
8	39492	9.02	4	34963.00	10.36	2	1027836	9.52	4	1243860.35	10.46	4
9	15522	3.55	10	10445.57	3.10	12	330261	3.06	9	309316.11	2.60	9
10	8235	1.88	15	7659.89	2.27	15	346111	3.21	8	294487.20	2.48	10
11	12282	2.81	11	10182.26	3.02	14	524534	4.86	6	536026.25	4.51	6
12	7022	1.60	17	5268.46	1.56	17	306051	2.84	11	277046.29	2.33	12
13	24597	5.62	8	19512.73	5.78	6	149047	1.38	16	140738.68	1.18	17
14	63523	14.52	1	27712.89	8.21	5	3437	0.03	23	1674.73	0.01	23
15	44118	10.08	3	18153.71	5.38	7	751	0.00	24	565.14	0.00	24
16	2415	0.55	23	2106.53	0.62	23	120913	1.12	19	98069.95	0.82	19
17	3356	0.77	21	3921.75	1.16	20	217398	2.01	13	220286.64	1.85	13
18	3552	0.81	20	3767.84	1.12	22	129374	1.20	18	193347.23	1.63	14
19	11347	2.59	12	10234.04	3.03	13	194088	1.80	14	185621.90	1.56	15
20	3281	0.75	22	4314.55	1.28	19	42431	0.39	21	33258.16	0.28	21
21	8828	2.02	14	7160.13	2.12	16	145693	1.35	17	151869.99	1.28	16
22	1029	0.24	24	2001.02	0.59	24	6837	0.06	22	15107.13	0.13	22
23	6501	1.49	19	4992.40	1.48	18	60241	0.56	20	51236.56	0.43	20
*24	6949	1.59	18	12682.79	3.76	11	269148	2.49	12	401953.86	3.38	8
TOTAL	437620	100.0		337490.1	100.0		10794183	100.0		11891242.51	100.0	

* includes DRGs 468 through 500 which are undefined procedures

medical insurance sponsored by the provincial government and in 1984/85 all active treatment hospitals participated in the PAS (Professional Activity Study) separation abstract system provided by the CPHA (Commission on Professional and Hospital Activities), Ann Arbor, Michigan. Thus, current data included all separations generated by Albertans in 1984/85. The same cannot be said about the U.S. data which was provided by the US Prospective Payment Assessment Commission (PPAC). Those persons aged 65 and over are covered by Medicare - an insurance plan which reimburses hospitals according to a prospective payment system (PPS) based on DRGs. Up until April, 1983, when the legislation enacting PPS was passed, only Medicare DRG-based systems existed. However, by 1986, eight states operated Medicaid DRG-based systems (Medicaid insurance covers those people, under 65, with low income). Thus, for this study the U.S. data were primarily made up of those covered by Medicare with some Medicaid separations.

For direct comparisons to be made between two groups they must be similarly composed. However, in this study the Alberta data were based on the total provincial population whereas in the U.S. only those 65 years and over (Medicare) and some of low income status (Medicaid) and younger (65-) were represented. The disparity between the two groups precluded any definitive conclusions regarding case-mix complexity. However, some general observations were made.

While Alberta had an AUSWE below average of 0.77, the U.S. had an AUSWE of 1.10 indicating a case mix of slightly above the U.S. theoretical average of 1.0. For both Alberta and the U.S., DRG codes were ranked according to weighted separations (USWE) to determine the top forty disease categories to which resources were allocated (Table 3). In Alberta for 1984/85, DRG 373 (Vaginal Delivery without complication or comorbidity) was ranked number one accounting for approximately 3% of total USWE. DRGs 468 (Unrelated Operating Room Procedure) and 98 (Bronchitis and Asthma, Age 0-17) followed, accounting for 2.6% and 1.7% respectively. The DRGW values for DRG 373 and DRG 98 were below average complexity. Ranking of the DRG codes differed when the weighting factor (DRGW) was ignored (SEPS represent unweighted separations) emphasizing the importance of relative resource requirements when analyzing resource allocation and consumption. While DRG 373 remained number one, the second and third ranked DRGs (when ranked according to SEPS) were DRG 391 (Normal Newborns) and DRG 390 (Neonates with other Significant Problems) and they acounted for 4.4% and 3.5% respectively of the total separations in Alberta.

In contrast, DRGs related to cardiovascular diseases dominated in the United States reflecting the older age group. Approximately 60% of hospital resources were consumed by less than one-tenth of all DRG groups representing 54% of the total separations. DRG 127 (Heart Failure and Shock) ranked number one making up 4.3% of total USWE. DRGs 14 (Specific Cerobrovascular Disorders except Transient Ischemic Attack) and 468 (Unrelated Operating Room Procedure) ranked second and third respectively. The USWE values for the three top ranked DRG codes (127, 14, 468) were all above average with respect to case-mix complexity. The ranking differed, as it did in Alberta, when the DRGW was ignored (unweighted separations). While DRG 127 remained number one, DRG 39 (Lens Procedures with/without Vitrectomy) and DRG 182

(Esophagitis, Gastroenteritis, and miscellaneous digestive disorders, >69 a/o complication or comorbidity) ranked second and third.

Table 4 shows resource consumption according to MDCs for both Alberta and the U.S. Ranked number one in Alberta was MDC 6 (Diseases and Disorders of the Digestive System) accounting for approximately 12% of total resource consumption. MDCs 8 (Diseases and Disorders of the Musculo-skeletal System and Connective Tissue) and 5 (Diseases and Disorders of the Circulatory System) ranked second and third with 10.36% and 10.27% respectively. Thus, these three MDCs - MDC 6, MDC 8, and MDC 5 - accounted for approximately one-third of total resource consumption. If relative resource requirements were not taken into account (SEPS), the ranking differed. MDC 14 (Pregnancy, Childbirth and the Puerperium System) ranked number one (14.52%) reflecting Alberta's relatively younger base population as compared with the U.S.

In the U.S., MDC 5 (Diseases and Disorders of the Circulatory System) ranked number one accounting for one-quarter of total resource utilization. Ranked second and third were MDCs 4 (Diseases and Disorders of the Respiratory System) and 6 (Diseases and Disorders of the Digestive System) accounting for 12.24% and 12.09% respectively. Therefore, almost 50% of total resource consumption was accounted for by three of the 23 MDCs. Though ranking changed slightly when relative resource requirement was ignored (SEPS), the same three MDCs were ranked among the top three.

The GMLOS (geometric mean length of stay) was compared between the U.S and Alberta. The GMLOS is a measure which more accurately measures length of stay (as compared to ALOS) because it minimizes the effect of outliers. Though the U.S. records a GMLOS, it is not a statistic routinely measured in Alberta; thus, it was necessary to derive a GMLOS for each DRG group. Only those marked (-) were able to be compared (Table 3). Thirteen of the 18 DRG codes had a GMLOS that was higher in Alberta than the U.S. This may be the result of the prospective reimbursement scheme in the U.S. which may lead to an early discharge whereas no similar pressure exists in the Canadian health care system.

4.2.3 Case Mix Comparison - Over 65

The case mix complexity comparisons made in the previous section were based on two disparately composed groups. To provide more definitive conclusions regarding the case mix complexity of the United States and Alberta, certain selection criteria were applied to the two data groups. With respect to the U.S. data, only those DRG codes which were applicable to persons 65 and over were selected. With respect to the Alberta data, persons under 65 years of age were excluded; thus, the two data sets were composed, primarily, of those 65 and over and were relatively more comparable.

The case mix complexity measure (AUSWE) of the U.S. remained virtually the same (1.11) whereas the AUSWE for Alberta increased substantially to 1.03 indicating a case mix almost equal to the U.S. theoretical average of 1.0. Again, the DRG codes were ranked according to weighted separations (USWE) to determine the top forty disease categories to which resources were allocated (Table 5). It should be noted that before the selection criteria were applied, only eighteen of

TABLE 5

DRG Codes Ranked According to Resource Consumption (USWE): Excluding Codes Not Applicable to those 65+/m

<====================Alberta====================>

USWE Rank	DRG	Description	DRGW	USWE*	USWE(%)	Estimate Cost($M)
1	127	Heart Failure and Shock	1.01	3.09	3.88	10.3
2	209	Major Jnt + Limb Reat	2.39	2.77	3.47	9.2
3	468	Unrelated O.R. Proc	2.45	2.50	3.13	8.3
4	182	Eso,Gas + Misc Dig, >69 a/o CC	0.60	2.35	2.95	7.8
5	88	Chron Obstruc Pulmon Dis	1.08	2.26	2.84	7.5
6	89	Simp Pneu + Pleur, >69 a/o CC	1.17	2.02	2.53	6.7
7	14	Spec CerVas Disor X TIA	1.31	1.96	2.46	6.5
8	154	Stb, Eso + Duo Proc, >69 a/o CC	2.69	1.65	2.07	5.5
9	148	MajSm+LgBowel Proc, >69 a/o CC	2.94	1.63	2.04	5.4
10	210	Hip + Fem X Maj Jnt. >69 a/o CC	2.03	1.47	1.84	4.9
11	96	Bronch + Asthma, >69 a/o CC	0.84	1.35	1.69	4.5
12	39	Lens Proc w/wo Vitrectomy	0.57	1.33	1.67	4.4
13	294	Diabetes, >35	0.75	1.33	1.66	4.4
14	122	Cir Disor w AMI wo CV, Alive	1.33	1.30	1.63	4.3
15	336	Transureth Pros, >69 a/o CC	0.99	1.20	1.51	4.0
16	110	Maj Rec Vas Proc w/o Pump, <69	3.31	1.18	1.48	3.9
17	138	Car Arr + Cond Dis, >69 a/o CC	0.81	1.04	1.31	3.5
18	140	Angina Pectoris	0.69	1.00	1.26	3.3
19	82	Resp Neoplasms	1.13	0.97	1.21	3.2
20	116	Perm Car Pace Imp a/o A,HF,S	2.99	0.91	1.14	3.0
21	197	Tot Chol w/o CDE, >69 a/o CC	1.71	0.90	1.13	3.0
22	243	Medic Back Problems	0.68	0.87	1.09	2.9
23	132	Atherscler, >69 a/oCC	0.80	0.80	1.00	2.7
24	123	Cir Disor w AMI, Expired	1.35	0.79	0.99	2.6
25	467	Other Fac Infl Health Status	0.72	0.78	0.98	2.6
26	121	Cir Disor w AMI + CV, Alive	1.77	0.78	0.98	2.6
27	320	Kid + Uri Trc Inf, >69 a/o CC	0.86	0.75	0.94	2.5
28	130	Kid + Uri Trc Inf, >69 a/o CC	0.83	0.74	0.93	2.5
29	174	GI Hemor, >69 a/o CC	0.91	0.71	0.88	2.3
30	403	Lymp/Leuk, >69 a/o CC	1.35	0.70	0.88	2.3
31	430	Psychoses	1.08	0.63	0.79	2.1
32	244	Bone Dis +Spec Arth, >69 a/o CC	0.67	0.63	0.79	2.1
33	75	Maj Chest Proc	2.98	0.62	0.78	2.1
34	134	Hypertension	0.64	0.57	0.71	1.9
35	172	Diges Malig, >69 a/o CC	1.07	0.53	0.67	1.8
36	12	Degener Nerv Sys Disor	1.00	0.51	0.64	1.7
37	429	Org Dist + Mental Retard	0.84	0.51	0.64	1.7
38	15	Tran Isch Attack + Prec Occl	0.62	0.51	0.64	1.7
39	1	Cran >17 X Trauma	3.56	0.49	0.62	1.6
40	146	Rectal Resec, >69 a/o CC	3.08	0.48	0.60	1.6
TOTAL				46.61	58.45	154.9

* in thousands

TABLE 5 (continued)

		<=====United States=====>			
USWE Rank	DRG	Description	DRGW	USWE*	USWE(%)
1	127	Heart Failure and Shock	1.01	505.57	4.25
2	14	Spec CerVas Disor X TIA	1.31	404.06	3.40
3	468	Unrelated O.R. Proc	2.45	395.80	3.33
4	89	Simp Pneu + Pleur, >69 a/o CC	1.17	353.53	2.97
5	209	Major Jnt + Limb Reat	2.39	338.47	2.85
6	148	MajSm+LgBowel Proc, >69 a/o CC	2.94	305.38	2.57
7	88	Chrom Obstruc Pulmon Dis	1.08	239.64	2.02
8	39	Lens Proc w/wo Vitrectomy	0.57	235.86	1.98
9	210	Hip + Fem X Maj Jnt. >69 a/o C	2.03	235.82	1.98
10	182	Eso,Gas + Misc Dig, >69 a/o CC	0.60	230.71	1.94
11	122	Cir Disor w AMI wo CV, Alive	1.33	215.77	1.82
12	140	Angina Pectoris	0.69	214.20	1.80
13	107	Coron Bypass w/o Car Cath	4.66	191.06	1.61
14	110	Maj Rec Jas Proc w/o Pump, <69	3.31	177.15	1.49
15	138	Car Arr + Cond Dis, >69 a/o CC	0.81	167.10	1.41
16	121	Cir Disor w AMI + CV, Alive	1.77	166.99	1.40
17	116	Perm Car Pace Imp a/o A,HF,S	2.99	154.85	1.30
18	87	Pulmon Edema + Respir Failure	1.81	150.29	1.26
19	96	Bronch + Asthma, >69 a/o CC	0.84	146.56	1.23
[illegible]	154	Sto, Eso + Duo Proc, >69 a/o C	2.69	142.62	1.20
[illegible]	243	Medic Back Problems	0.68	141.16	1.19
22	82	Resp Neoplasms	1.13	141.15	1.19
23	336	Transureth Pros, >69 a/o CC	0.99	139.83	1.18
24	296	Nut + Mis Met Disor,>69 a/o CC	0.83	132.59	1.12
25	174	GI Hemor, >69 a/o CC	0.91	123.51	1.04
26	197	Tot Chol w/o CDE, >69 a/o CC	1.71	121.41	1.02
27	320	Kid + Uri Trc Inf, >69 a/o CC	0.86	118.15	0.99
28	15	Tran Isch Attack + Prec Occl	0.62	107.90	0.91
29	132	Atherscler, >69 a/oCC	0.80	99.28	0.84
30	112	Vasc Proc X Maj Recw w/o Pump	2.21	97.29	0.82
31	416	Septacemia, >17	1.62	96.76	0.81
32	106	Coron Bypass w Car Cath	5.33	96.23	0.81
33	294	Diabetes, >35	0.75	95.30	0.80
34	430	Psychoses	1.08	92.15	0.78
35	123	Cir Disor w AMI, Expired	1.35	91.72	0.77
36	5	Extracran Vasc Proc	1.65	89.60	0.75
37	79	Res Infec + Inflam, >69 a/o CC	1.93	86.96	0.73
38	75	Maj Chest Proc	2.98	81.12	0.68
39	130	Kid + Uri Trc Inf, >69 a/o CC	0.83	80.61	0.68
40	403	Lymp/Leuk, >69 a/o CC	1.35	73.46	0.62
				7077.62	59.54

*in thousands

the top forty ranked DRGs were common between Alberta and the United States. Afterwards, thirty-two of the top forty DRGs were common to both groups indicating the increased comparability between the two.

DRG 127 (Heart Failure and Shock) was ranked number one in both Alberta and the United States accounting for approximately 3.9% and 4.3% of total USWE respectively. Ranking second and third in Alberta with respect to USWE were DRGs 209 (Major Joint and Limb Reattachment Procedures) and 468 (Unrelated O.R. Procedures) accounting for 3.5% and 3.1% respectively. The DRGs ranking second and third in the U.S. were 14 (Specific Cerebrovascular Disorders expect TIA) and 468 (Unrelated O.R. Procedures) making up 3.4% and 3.3% of total USWE respectively. In both Alberta and the U.S., approximately 60% of hospital resources were consumed by about one-tenth of all DRG groups included in the analysis.

4.2.4 Summary of Findings

In the previous section, several observations were made regarding case mix complexity in Alberta; as well, comparisons were made between the U.S. and Alberta.

(1) In Alberta, approximately 41% of hospital resources were consumed by less than one-tenth of all DRG groups. This represented 44% of total separations and 45% of total patient-days. Estimated total cost for the top forty DRGs totalled 463.4 million dollars.

(2) The top three MDCs, ranked according to USWE, accounted for 33% of total resource consumption.

(3) The Alberta data were based on the total provincial population whereas in the U.S. only those 65 years and over (Medicare) and some of

low income status (Medicaid) were represented; thus, precluding any definitive conclusions regarding case-mix complexity comparisons.

(4) The AUSWE for Alberta was 0.77 (slightly below the U.S. theoretical average of 1.0) while the U.S. Medicare patients had an AUSWE of 1.10.

(5) DRG codes were ranked according to USWE. In Alberta, DRG 373 (Vaginal Delivery without complication or comorbidity) ranked number one while DRG 127 (Heart Failure and Shock) ranked number one in the U.S. reflecting the older age group.

(6) In Table 4, USWE was broken down according to MDCs. In Alberta, accounting for about 12% of total resources and ranked number one was MDC 6 (Diseases and Disorders of the Digestive System). In the U.S., MDC 5 (Diseases and Disorders of the Circulatory System) was ranked number one accounting for 25% of total resource consumption.

(7) Regarding GMLOS, selected DRGs were compared between the U.S. and Alberta. Thirteen of the 18 DRG codes had a GMLOS which was higher in Alberta than the U.S.

(8) In both Alberta and the U.S., DRG 127 (Heart Failure and Shock) ranked number one when the two data sets were composed of only those 65 years of age and older. The AUSWE for Alberta increased from 0.77 to 1.03 while the AUSWE for the U.S. remained relatively stable at 1.11.

4.3 Hospital Analysis

In this section, Alberta hospitals are analyzed using various utilization measures. All acute care hospitals are included in the analysis; however, separations associated with a length of stay (LOS) of 121 days or more were excluded as these were considered long term care patients. Two types of rates were derived - (1) per case rates (e.g. PDAY/SEP, USWE/SEP) and (2) per capita rates (e.g. SEPRATE, PDAYRATE). The per case rates disregard the population served and were derived for hospital-specific analyses whereas the per capita rates are population based utilization measures and, thus, facilitated a population based analysis. The focus of this section is hospital performance in terms of resource utilization and allocation and will include: (1) outline of three hospital classification methods used; (2) hospital-specific analysis; and (3) population-based analysis.

4.3.1 Hospital Classification

Size, level of care, and location are three factors upon which the performance of a hospital may depend. Thus, for the following sections, three hospital classifications were used.

Firstly, the acute care hospitals in Alberta were classified into four categories dependent upon the size of the hospital which was measured according to its approved bed complement. **Small** hospitals were considered to be those facilities with total acute care beds numbering between 1 and 99. A hospital having 100-299 beds was classified as a **medium-sized** hospital and those with a bed complement ranging from 300 to 499 beds were categorized as **large**. The remaining hospitals (those with 500 beds or more) were considered **healthcenters** and classified in the fourth group.

The **level of care** provided by a hospital may also affect its performance. The second hospital classification was based upon three levels of care. The hospitals classified as **tertiary care** facilities were: University of Alberta, Royal Alexandra, WW Cross, Foothills, Calgary General, and Alberta Children's Hospital. Twelve hospitals were classified as **secondary care** hospitals and included the Salvation Army, the Holy Cross and the Rocky View in Calgary; the General, the Misericordia and the Camsell in Edmonton; the Municipal and St. Michael's in Lethbridge; and the general hospitals in Grande Prairie, Medicine Hat, Red Deer and Ft. McMurray. The remaining 106 hospitals were considered **primary care** facilities.

Lastly, a hospital was classified on the basis of its location which involved three subgroups: Metropolitan, Regional, and Rural. Those hospitals located in either Metro Edmonton or Metro Calgary were classified in the **metropolitan** group. The **regional** hospitals included Medicine Hat General, Lethbridge Municipal, Lethbridge St. Michael's, Red Deer Regional, Ft. McMurray Regional, and Grande Prairie General. The remaining 105 acute care hospitals were classified as **rural** facilities.

4.3.2 Hospital-Specific Analysis

Both per case rates and per capita rates, describing hospital resource allocation and utilization, were derived for each of the 124 acute care hospitals in Alberta and are summarized in Appendix A.2. For the hospital-specific performance analysis, however, the population served is disregarded; thus, only per case rates were analyzed in this section. The three classification methods previously discussed - size, level of care, and location - were applied for presenting the results (see Table 6).

TABLE 6

Hospital-Specific Utilization Measures
1984/85

Grouped By	Group	No. Hosp	No. Beds	(%)	SEP *	(%)	PDAY *	(%)	USWE *	(%)	ALOS	AUSWE
SIZE	Small	103	3793	31.6	130	29.7	731	24.7	89	26.3	5.6	0.68
	Medium	12	1945	16.2	83	18.9	513	17.4	61	18.0	6.2	0.74
	Large	2	714	6.0	26	5.9	191	6.5	20	5.9	7.4	0.78
	Healthcenter	7	5538	46.2	199	45.4	1519	51.4	168	49.7	7.6	0.84
	TOTAL	124	11990	100.0	438	100.0	2954	100.0	338	100.0		
LEVEL	Primary	106	4263	35.6	148	33.8	835	28.3	101	29.9	5.7	0.68
	Secondary	12	3664	30.6	147	33.6	1017	34.4	115	34.0	6.9	0.78
	Tertiary	6	4063	33.9	143	32.6	1102	37.3	122	36.1	7.7	0.85
	TOTAL	124	11990	100.0	438	100.0	2954	100.0	338	100.0		
LOCATION	Metropolitan	13	6595	55.0	237	54.1	1767	59.8	197	58.3	7.5	0.83
	Regional	6	1326	11.1	57	13.0	384	13.0	43	12.7	6.8	0.76
	Rural	105	4069	33.9	144	32.9	803	27.2	98	29.0	5.6	0.68
	TOTAL	124	11990	100.0	438	100.0	2954	100.0	338	100.0		
PROVINCIAL		124	11990		438		2954		338		6.75	0.77

* in thousands

For the province as a whole, in 1984/85, 437,620 separations were recorded and 2,953,493 patient days were generated. When DRGWs were applied, the USWE was 337,820 with a low of 63 and a high of 35,325. When the hospitals were classified according to size, it was found that for all three utilization measures (USWE, PDAY, and SEP), the healthcenters accounted for approximately half of the respective totals (Table 6). Owing to the fact that these facilities accounted for 46% of the 11,990 beds in the province, the results were expected. A similar pattern emerged when hospitals were classified by location. The 'metropolitan' hospitals captured between 50-60% of total SEP, total PDAY, and total USWE. However, when classified by level of care, each of the three hospital utilization measures appeared relatively equal across the three levels of care. Correspondingly, the total number of beds were relatively evenly distributed among primary, secondary, and tertiary care.

Two per case utilization indicators were calculated: (1) AUSWE (average resources need index per separation) and (2) ALOS (average number of patient days per separation). It should be noted that per case utilization measures are less sensitive indicators of hospital utilization than per capita measures in view of the diluting or inflation effect of the referral movement of patients. This effect is caused by the fact that separation abstracts are submitted for each hospital admission and transfer; thus, for referred patients, more than one separation abstract would be generated for a single illness episode, raising utilization rates toward an over-representation of the actual number of patients treated.

The average USWE (AUSWE), a measure of case mix complexity, was derived by dividing USWE by SEP and ranged from 0.59 to 3.38. An AUSWE of 0.77 was derived for Alberta; this is below the theoretical U.S. average of 1.0. When hospitals were broken down by level of care, the AUSWE increased from 0.68 for primary care to 0.85 for tertiary care (Table 6). As tertiary care facilities treat a more complex case mix than primary care hospitals, this was an anticipated result. Similar increases in AUSWE were evident when hospitals were classified by size and location (see Figure 3).

Average length of stay (ALOS) was computed by dividing PDAY by SEP. The ALOS ranged from 2.7 days to 19.8 days with a provincial average of 6.75 days. There was consistency across all three classification methods (Table 6) with healthcenters, tertiary care facilities, and hospitals located in metropolitan areas having the highest ALOS (7.6, 7.7, 7.5 days respectively) and the small hospitals, primary care facilities and hospitals located in the rural areas experiencing relatively shorter ALOSs (5.6, 5.7, 5.6 days respectively) (see Figure 4). The trend most probably reflects the variation in case-mix complexity between small and large hospitals, primary care and tertiary care facilities, and those hospitals located in the rural areas versus the metropolitan areas.

Hospital specific cost per case and AUSWE (case-mix complexity) have often been associated with one another (Bentley & Butler, 1982). To examine whether an increase in AUSWE results in an increase in cost per case, a regression analysis was performed resulting in the following regression equation:

Figure 3

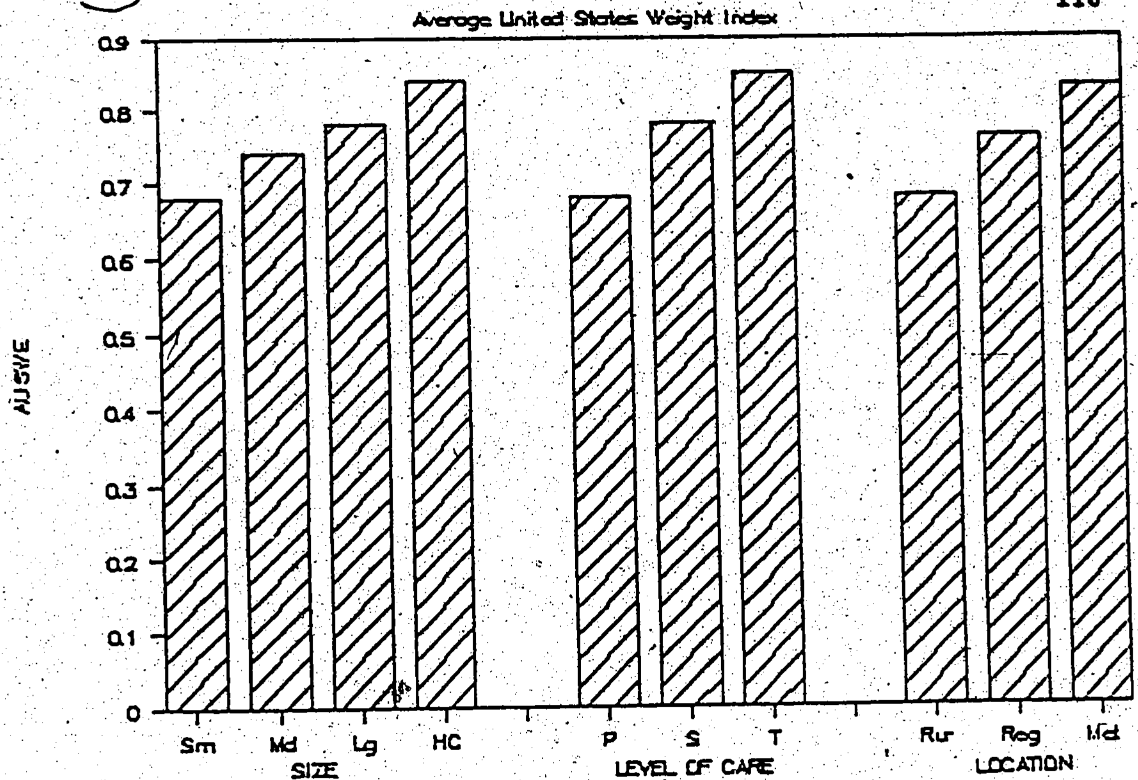
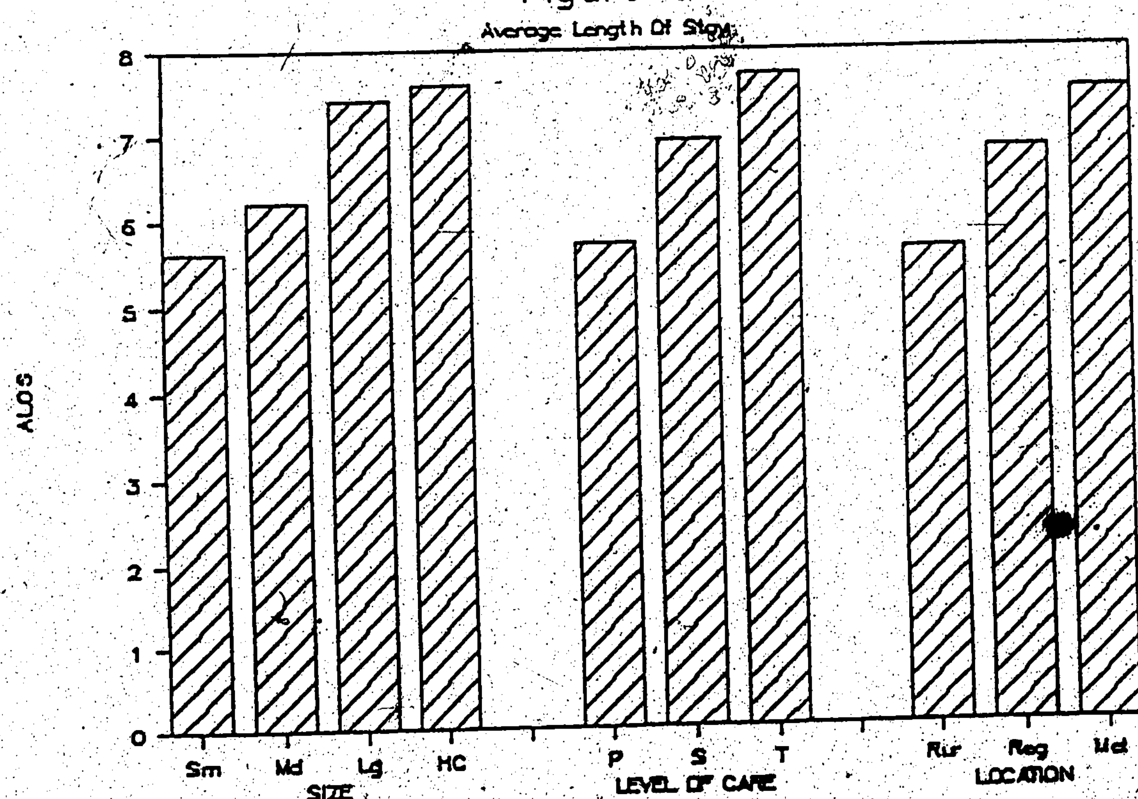


Figure 4



$$COST/SEP = -3.06 + 7194.78 \cdot (AUSWE); \quad R^2 = 0.71$$

From the equation, it may be observed that the cost per case would increase by about $7200.00 dollars with a one unit increase in AUSWE. The case mix measure (AUSWE) explained about 70% of per case cost variation among Alberta hospitals.

4.3.3 Population-Based Analysis

To compute per capita rates, the service population of each hospital must be estimated. The service population size of any one hospital refers to the number of age-sex-adjusted residents served by that hospital. Two methods for estimating hospital service populations were used - the Relevance Index method and the Commitment Index method (see Appendix B). The per capita rates were calculated using, in the denominator, the **average** of these two statistics. Use of the average service population was justified based on the fact that both estimates were highly correlated, with a Spearman rank correlation of 0.96. (The Pearson correlation was approximately 0.99). Bay and Nestman (1980) also demonstrated a high correlation between hospital service population estimates derived using the Relevance Index and Commitment Index methods.

The population-based rates derived are shown in Table 7 broken down by three hospital classification methods - size, level of care, and location. Refer to Appendix A.2 for per capita rates specific to each acute care hospital.

By definition, the total service population for Alberta is the same as the census population. Some hospitals served a population as small

TABLE 7

Population-Based Hospital Rates
1984/85

Grouped By	Group	No. of Hosp	No. of Beds	(%)	SP *	(%)	SPI	SEP RATE	PDAY RATE	USWE RATE	COST RATE
SIZE	Small	103	3793	31.6	479.1	21.4	126.3	0.271	1.53	0.185	491.6
	Medium	12	1945	16.2	393.2	17.6	202.2	0.211	1.30	0.155	467.7
	Large	2	714	6.0	139.3	6.2	195.1	0.187	1.37	0.147	440.9
	Healthcenter	7	5538	46.2	1225.7	54.8	221.3	0.162	1.24	0.137	426.4
	TOTAL	124	11990	100.0	2237.3	100.0					
LEVEL	Primary	106	4263	35.6	563.9	25.2	132.3	0.262	1.48	0.179	422.0
	Secondary	12	3664	30.6	785.1	35.1	214.3	0.188	1.30	0.147	394.1
	Tertiary	6	4063	33.9	888.2	39.7	218.6	0.161	1.24	0.137	513.5
	TOTAL	124	11990	100.0	2237.3	100.0					
LOCATION	Metropolitan	13	6595	55.0	1455.2	65.0	220.7	0.163	1.21	0.135	455.3
	Regional	6	1326	11.1	254.4	11.4	191.8	0.224	1.51	0.169	453.4
	Rural	105	4069	33.9	527.7	23.6	129.7	0.273	1.52	0.185	427.5
	TOTAL	124	11990	100.0	2237.3	100.0					
PROVINCIAL		124	11990		2237.3		186.6	0.195	1.32	0.151	448.5

* in thousands

as 441 while other hospitals served a population of 224,184. Health centers and those healthcare facilities located in metropolitan regions served approximately 55% and 65% of the total service population respectively while small hospitals and rurally located facilities served 21% and 24% of the total service population (Table 7). When hospitals were classified by level of care, there was a gradual increase in service population from primary care (25.2%) to tertiary care (39.7%).

Alberta generated 0.151 weighted separations per capita (USWERATE) in 1984/85 ranging from a high of 0.346 to a low of 0.07. The USWERATE was 0.185 for hospitals classified as small which was well above the provincial rate. This rate steadily declined as hospital size increased with the healthcenters having a USWERATE of 0.13[illegible] (see Figure 5). Figure 5 shows a similar decline in USWERATE when hospitals were classified according to both level of care and location. The USWERATE ranged from 0.179 for primary care hospitals to 0.137 for tertiary hospitals and from 0.185 for rural hospitals to 0.135 for metropolitan-located hospitals. Thus, despite the fact that healthcenters, tertiary care and metropolitan hospitals generated more weighted separations than other hospitals (as shown in the previous section), they have relatively lower USWERATES owing to the fact that the per capita rate acknowledged the larger service population served by these hospitals.

Alternate utilization measures including SEPRATE (number separations per capita) and PDAYRATE (number of patient-days per capita) were calculated (Table 7). Both of these measures, however, do not recognize variation in resource requirement between hospitals owing to case mix differences as does the USWERATE previously discussed.

Figure 5

Weighted Sep Per Capita (USWERATE)

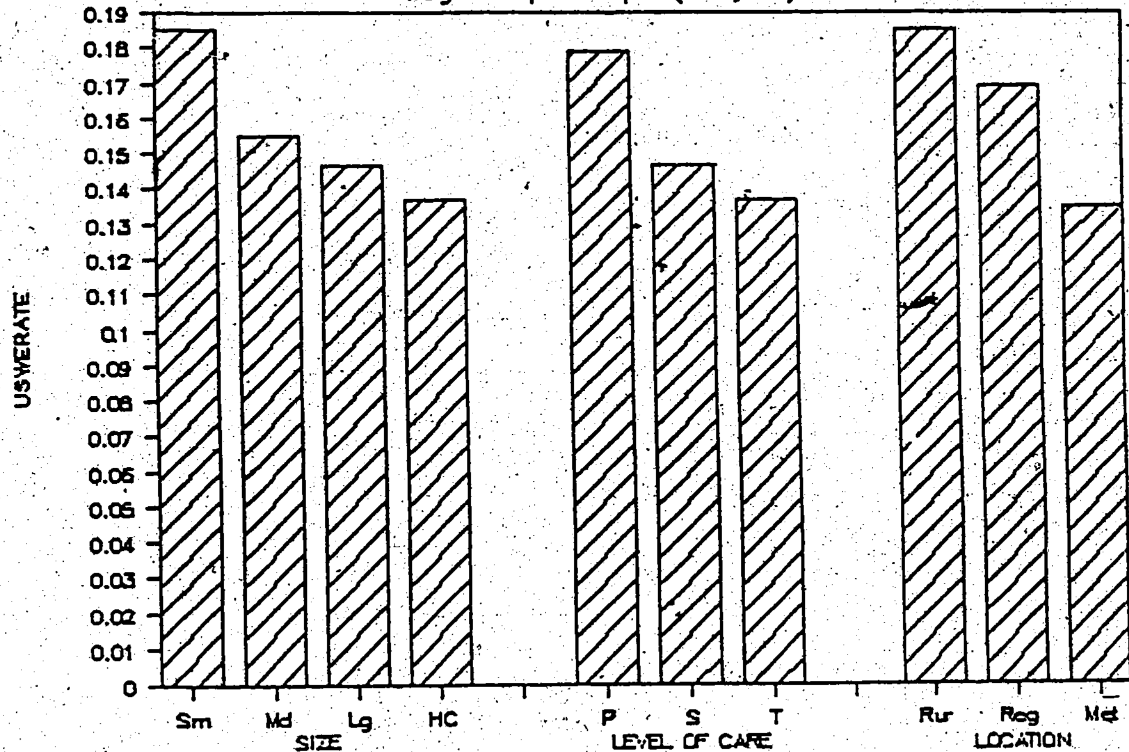
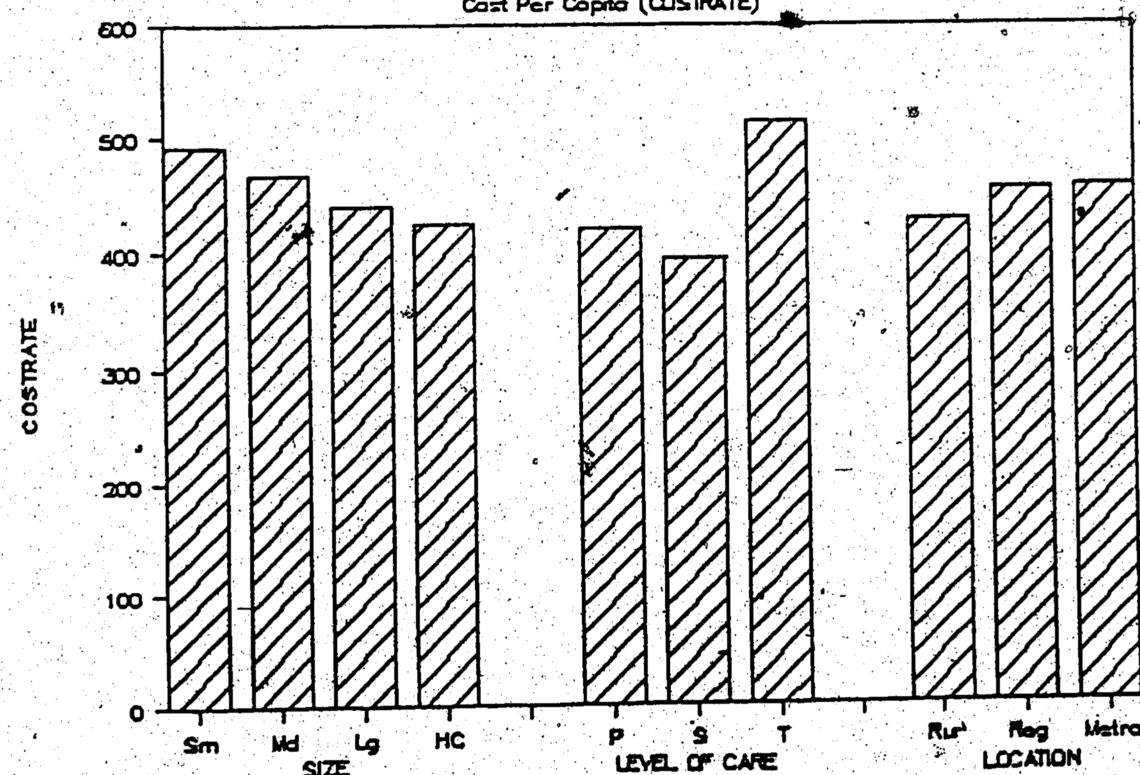


Figure 6

Cost Per Capita (COSTRATE)



Comparable to USWERATE, SEPRATE was highest for small hospitals, primary care facilities and those hospitals located in rural areas (0.271, 0.262, 0.273 separations per capita respectively) and lowest for healthcenters, tertiary care facilities and metropolitan-located hospitals (0.162, 0.161, 0.163 separations per capita respectively). From a provincial perspective, when resource requirements were ignored, Alberta had a SEPRATE of 195 per 1,000 persons versus a USWERATE of 151 per 1,000 persons when case mix variation was recognized. PDAYRATE behaved in a similar manner to both USWERATE and SEPRATE declining from highs of 1.53, 1.48 and 1.52 for small, primary care, and rural hospitals to lows, below the provincial PDAYRATE, of 1.24, 1.24, and 1.21 for healthcenters, tertiary care and metropolitan hospitals. Again, though the "bigger" hospitals generated more separations and more patient days, they were also shown to serve a larger service population; thus, resulting in lower per capita rates.

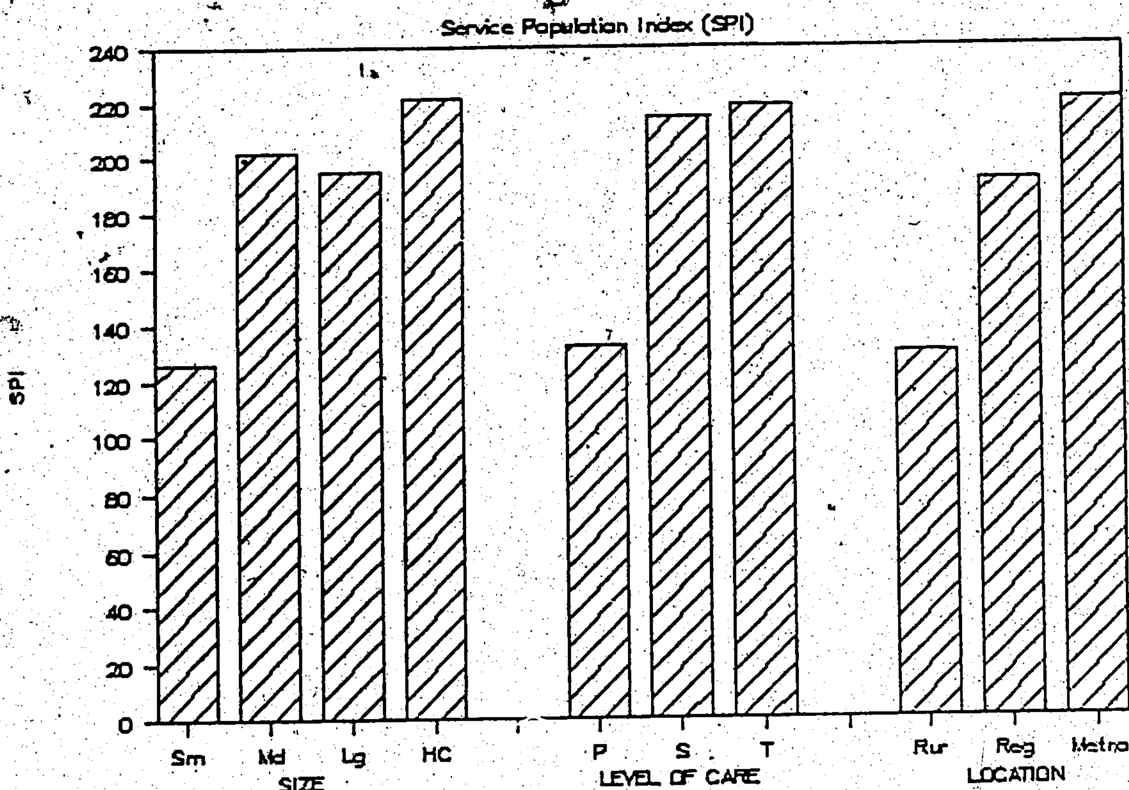
By dividing cost by service population, a COSTRATE was computed (Table 7). Figure 6 shows the COSTRATES broken down by size, level of care, and location. The small hospitals incurred a per capita cost of $491.60 which steadily declined to $426.40 per capita for healthcenters. Most probably, the reason for this decline is economies of scale which may be achieved by the large health centers. The same pattern was not evident when hospitals were classified by level of care. Appropriately, the tertiary care facilities had the highest COSTRATE of $513.50. The secondary care hospitals had a lower COSTRATE ($394.10) than the hospitals classified as primary care facilities (COSTRATE = $422.00) probably due to the primary care facilities' small scale operations as well as sparse population densities. When COSTRATE and location of hospital were examined, rural hospitals had a COSTRATE of $427.50 versus a COSTRATE in the metropolitan hospitals of $455.30. Regional hospitals had a COSTRATE similar to the latter of $453.40.

The service population index (SPI) is an estimate of the number of persons served by each hospital bed and was computed by dividing service population by the number of beds. The larger the SPI, the more efficient use of beds or, alternatively, the hospital is overloaded. Figure 7 illustrates the SPIs for each classification method. Overall, the SPI increased as one moved from small to large hospitals, primary to tertiary care facilities, and rural to metropolitan hospitals. The SPIs for small, primary care, and rural hospitals were 126.3, 132.3 and 129.7 respectively. It must be noted that SPIs for "smaller" hospitals were expected to be lower than those for "larger" hospitals because of the need to maintain relatively lower occupancy rates in order to meet fluctuating emergency or urgent demands. The medium-sized hospital had a higher SPI than the large hospital. This could imply that medium-sized hospitals are more efficient than large hospitals (300-500 beds) or it could mean that medium-sized facilities are overloaded relative to large-sized hospitals.

4.3.4 Summary of Findings

In the previous section, the performance of Alberta hospitals with respect to resource utilization and allocation was analyzed and revealed the following:

Figure 7


Service Population Index (SPI)
SPI
240
220
200
180
160
140
120
100
80
60
40
20
0
Sm
Md
Lg
HC
SIZE
P
S
T
LEVEL OF CARE
Rur
Reg
Metro
LOCATION

(1) When hospitals were classified by size or location, it was found that for all three utilization measures (USWE, SEP, and PDAY), the healthcenters or metropolitan-located hospitals accounted for approximately half of the respective totals. These facilities also accounted for half of the provincial hospital beds (46% - healthcenters; 55% - metropolitan); thus, the results were not unexpected. The same pattern did not emerge when hospitals were classified by level of care. The utilization measure appeared relatively equal for the three levels as did the number of beds.

(2) A measure of case-mix complexity was derived (AUSWE) and equalled 0.77 for Alberta as a whole. For all three classification methods, the AUSWE increased as one moved from small (0.68) to large (0.84) hospitals, primary (0.68) to tertiary care (0.85) facilities and rural hospitals (0.68) to hospitals located in metropolitan areas (0.83). It was further found that the case mix measure (AUSWE) explained about 70% of per case cost variation among Alberta hospitals.

(3) Average length of stay (ALOS) was also examined. Most probably reflecting the variation in case-mix complexity, the author observed a general increase in ALOS as hospital size increased, level of care increased, and for hospitals located in metropolitan areas.

(4) The USWERATE (number of weighted separations per capita) ranged from a low of 0.07 to a high of 0.346 with a provincial USWERATE of 0.151. The USWERATE for hospitals classified as small was 0.185 and this rate steadily declined as hospital size increased with the healthcenters having a USWERATE of 0.137. A similar decline in USWERATE was observed when hospitals were classified either by level of care or

location.

(5) A COSTRATE was also computed and broken down by size, level of care, and location. While an inverse relationship was observed between the size of a hospital and per capita cost, the same could not be said when hospitals were classified by level of care. The tertiary care facilities had the largest per capita cost of $513.50.

(6) The SPI (Service Population Index) was utilized to estimate the number of persons served by each hospital bed and ranged from a low of 42.5 persons served per bed to a high of 282.8 persons per hospital bed.

4.4 District Analysis

The geographic characteristics of Alberta are such that the GHDs in the northern part of the province tend to be large in terms of geographic area but low in population density. On the other hand, the central and southern GHDs are relatively small in geographic area but have higher population densities. An important reason for analyzing district resource utilization variations is to investigate the equitableness of resource allocation among district residents and hospitals. The following sections examine the variability in resource utilization with the focus of the analysis being the effects of case mix (as measured by AUSWE) and geographic factors on resource utilization. The district analysis will incorporate the following sections: (1) GHD analysis; (2) regional analysis; and (3) metro-suburban-rural area analysis.

4.4.1 GHD Analysis

Appendix A.3 presents the utilization rates calculated for each general hospital district for the fiscal year 1984/85. To avoid the influence of district size, per case utilization rates (ALOS, AUSWE) and per capita utilization rates (USWERATE, SEPRATE, PDAYRATE, BDI) were derived. The denominators used to compute the per capita rates were age-sex adjusted service population figures; thus, these rates do not reflect disparities with respect to the age-sex composition of the population. Also presented in Appendix A.3 are the totals for each GHD with respect to service populations, separations, patient-days, weighted separations, and beds.

Table 8 provides a summary of Appendix A.3, displaying per case and per capita utilization rates. ALOS (average length of stay) ranged from a minimum of 4.4 patient-days in Whitecourt GHD to a maximum of 10.0 patient-days in Myrnam GHD with a median of 6.5. The provincial ALOS was 6.8 patient-days. The second per case rate, AUSWE, is a measure of case mix complexity. The AUSWE ranged from 0.66 to 1.26 with two northern GHDs (Slave Lake and Ft. Vermillion) exhibiting the minimum rate. This result may be partially due to the limited range of services in the northern regions; thus, patients requiring surgical care may be transferred to another hospital resulting in multiple separations for surgical cases. The maximum AUSWE originated from the Elnora GHD which is located just southeast of Red Deer. The median equalled 0.76 which was similar to the provincial rate of 0.77.

With respect to per capita rates, the USWERATE ranged from a minimum of 0.059 weighted separations per capita obtained in

Table 8

Summary of Per Case and Per Capita Utilization Rates

Variable		Statistics	Values
ALOS	Patient Days/Separations	Minimum	4.4
		1st Quartile	6.0
		Median	6.5
		3rd Quartile	7.1
		Maximum	10.0
AUSWE	Weighted Separations/ Separations	Minimum	0.66
		1st Quartile	0.74
		Median	0.76
		3rd Quartile	0.80
		Maximum	1.26
USWERATE	Weighted Separations/ Capita	Minimum	0.059
		1st Quartile	0.165
		Median	0.185
		3rd Quartile	0.219
		Maximum	0.537
SEPRATE	Separations/Capita	Minimum	0.064
		1st Quartile	0.207
		Median	0.243
		3rd Quartile	0.285
		Maximum	0.782
PDAYRATE	Patient Days/Capita	Minimum	0.44
		1st Quartile	1.41
		Median	1.59
		3rd Quartile	1.80
		Maximum	4.75
BDI	Rated Beds/1000 Capita	Minimum	3.4
		1st Quartile	6.3
		Median	7.0
		3rd Quartile	9.0
		Maximum	18.3

Lloydminster GHD which is located on the Alberta/Saskatchewan border to a maximum of 0.537 in Vilna GHD; a relatively small district northeast of Edmonton. The low USWERATE obtained in Lloydminster GHD was most probably due to the general hospital being located in Saskatchewan. Regarding the high USWERATE in Vilna GHD, perhaps residents in this area are in need of relatively more hospital care than other GHD residents or a supply-demand phenomenon is occurring owing to the comparatively high BDI which is subsequently noted. The median USWERATE was 0.185 weighted separations per capita. The average number of separations originated by each district varies from a minimum of 0.064 cases per capita to a maximum of 0.782. The average number of patient-days generated by each district ranged between 0.44 and 4.75 per capita with a median of 1.59 patient-days.

The Bed Distribution Index (BDI) measures the distribution of beds over geographic districts. It is defined as the number of beds per 1,000 age-sex adjusted residents and identifies potentially under-or-overbedded GHDs. The BDI was computed by dividing the number of beds allocated to the district by the service population of that district. Two methods, the Relevance Index method and the Commitment Index method were used to compute the numerator of this rate (see Appendix B); however, the BDI was calculated using the average of these two estimates. This process was justified based upon the fact that the two estimates were highly correlated with a Spearman rank correlation of 0.97. (The Pearson Correlation was 0.99). Previously, Bay and Nestman (1980) demonstrated a high correlation between rated bed estimates derived using the two methods mentioned previously. The BDI ranged from a minimum of 3.4 beds in Turner Valley GHD to a maximum of 18.3 beds in Vilna GHD with a median of 7.0. Though a number of factors must be considered, VIlna GHD appeared to be a potentially overbedded district.

The GHD analysis produced very specific results (Appendix A.3); however, the GHDs differ considerably with respect to geography and level of urbanization (which is associated with the availability of services). In addition, many districts are too small to produce stable results. Therefore, to obtain a clearer picture of resource utilization variation, GHDs were grouped in two ways: (1) regional classification; and (2) metro-suburban-rural area classification.

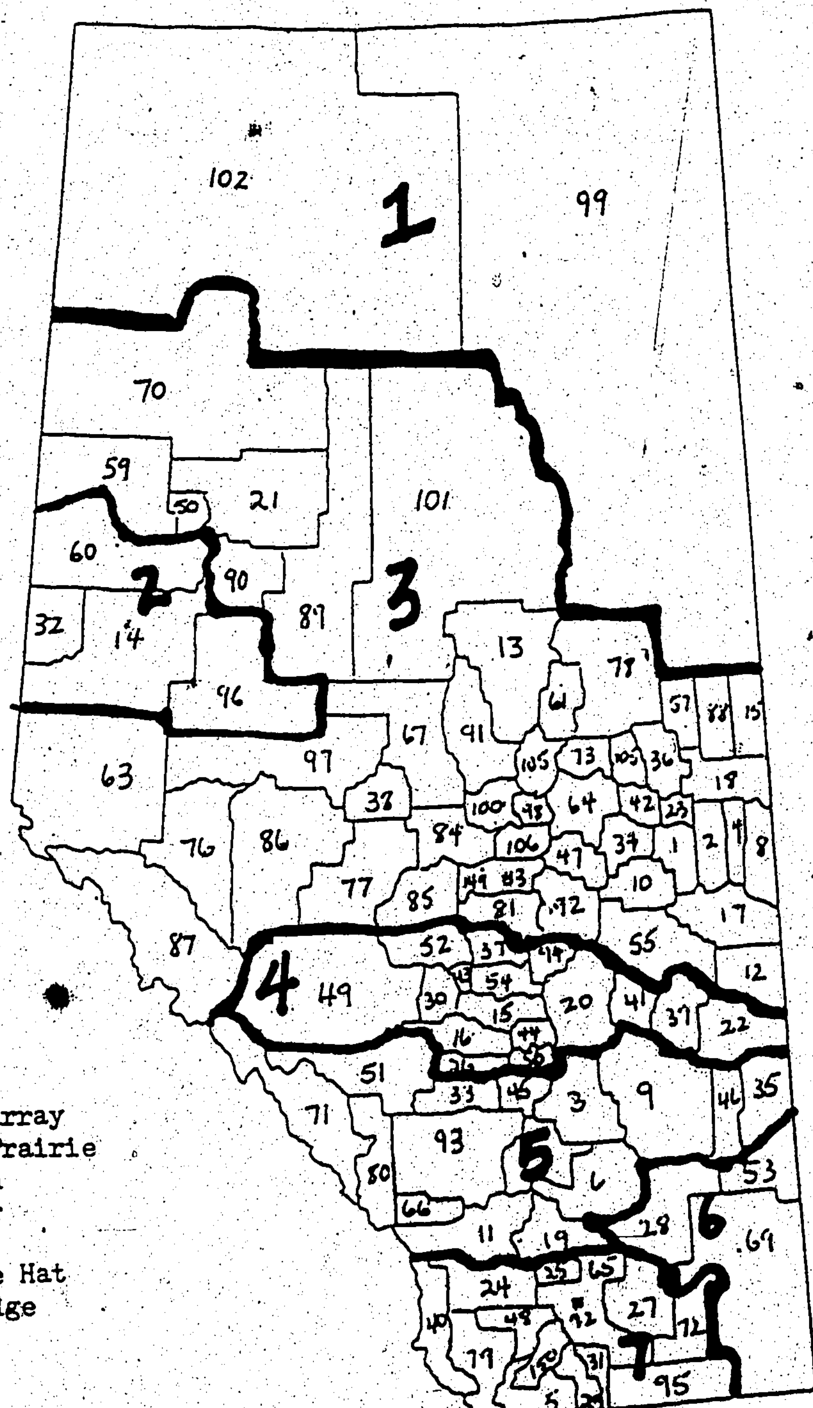
4.4.2 Regional Analysis

As most of the GHDs in Alberta encompass relatively small areas the GHDs were grouped into seven major regions according to geographic contiguity, traffic routes, and referral patterns as used by the Alberta government. The seven regions are shown in Figure 8 and included: Ft. McMurray, Grande Prairie, Edmonton, Red Deer, Calgary, Medicine Hat, and Lethbridge.

Two types of per case rates were examined - ALOS and AUSWE (Table 9). Ft. McMurray region had the lowest ALOS of 5.9 patient-days while Red Deer and Calgary regions exhibited the highest ALOS (7.1 patient-days). Edmonton region constituted the middle of these two extremes with an ALOS of 6.7 patient-days. One might expect Edmonton region to have a similar ALOS to Calgary region; however, it must be noted that the former region incorporated relatively more rurally located GHDs (Figure 8) which exhibited lower ALOS rates than those GHDs located near or in urban centers.

Figure 8

Regional Divisions



1 Ft. McMurray
2 Grande Prairie
3 Edmonton
4 Red Deer
5 Calgary
6 Medicine Hat
7 Lethbridge

Table 9

Regional Specific Utilization Measures

Region	ALOS	AUSWE	SEP RATE	USWE RATE	PDAY RATE	BDI
Ft. McMurray	5.9	0.68	0.341	0.233	2.01	7.1
Grande Prairie	6.2	0.73	0.251	0.185	1.57	6.4
Edmonton	6.[illegible]	0.77	0.202	0.155	1.34	5.6
Red Deer	7.1	0.79	0.211	0.167	1.49	5.9
Calgary	7.1	0.78	0.161	0.126	1.14	4.5
Medicine Hat	6.5	0.77	0.202	0.157	1.32	5.1
Lethbridge	6.5	0.78	0.237	0.185	1.54	6.3
PROVINCIAL	6.8	0.77	0.195	0.151	1.32	5.4

AUSWE ranged from 0.68 in Ft. McMurray to 0.79 in Red Deer. Correspondingly, these two regions had the lowest and highest ALOSs. Consistent with previous results, the northern regions of Alberta - Ft. McMurray and Grande Prairie - presented a case-mix complexity measure below the provincial rate of 0.77 while the remaining five regions had AUSWEs above or equal to the provincial rate. This suggested that (1) perhaps physicians in the northern region are more conservative with respect to the types of patients admitted; thus, more patients requiring less care and fewer resources are the ones admitted; (2) the range of services available in a northern district does not compare with those available in urban areas; thus, limiting the type of admission.

The USWERATE (number of weighted separations per capita) was calculated for each of the seven regions (see Figure 9). Table 9 shows that six out of the seven regions had a USWERATE above the provincial rate with Ft. McMurray generating the highest USWERATE of 0.233. Calgary region was the only one with a rate lower than the provincial rate. One might have expected Edmonton region to behave the same way; however, this region incorporated many more rural districts which tended to have high USWERATES as shown in the following section.

SEPRATE and PDAYRATE were two other utilization measures used in the analysis. SEPRATE followed a similar pattern to USWERATE but owing to the fact that resource variation is ignored with this measure, it was observed that SEPRATE was higher than USWERATE for every category. Ft. McMurray had a high SEPRATE (0.341) while the Calgary region had a low SEPRATE (0.161). With respect to PDAYRATE, the two aforementioned regions claimed, again, the highest and lowest rates. Both Edmonton and

Figure 9

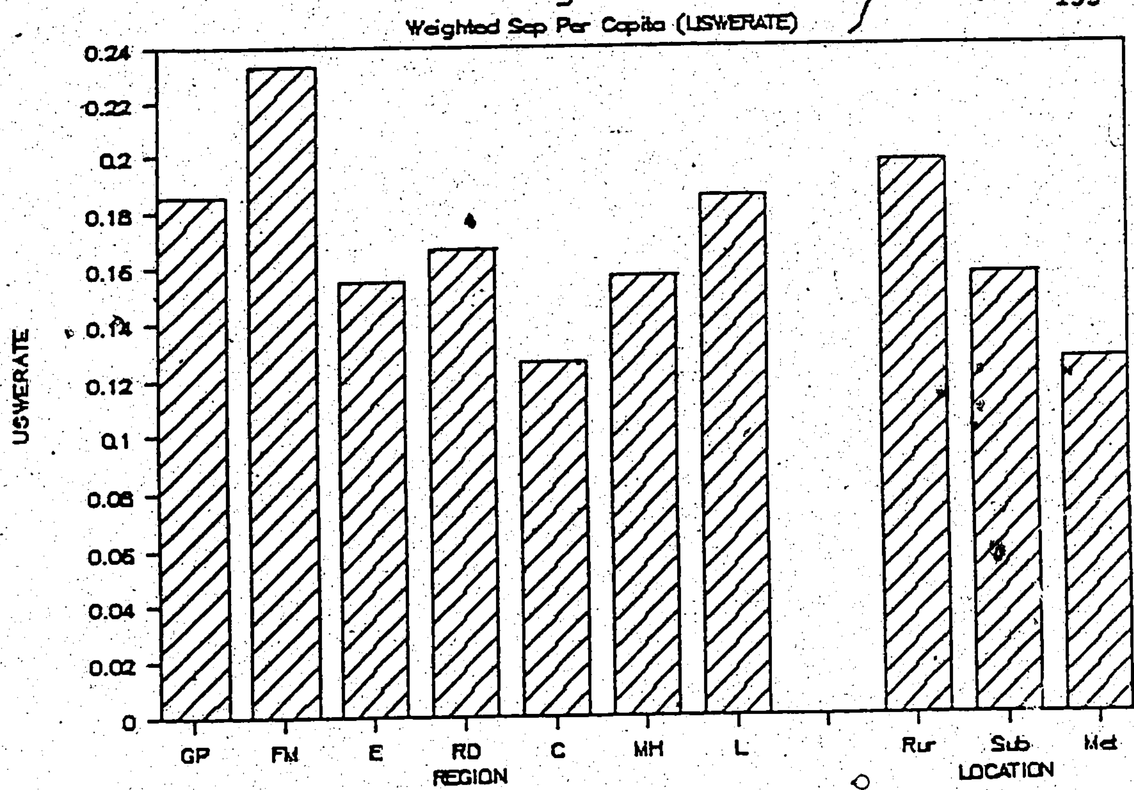
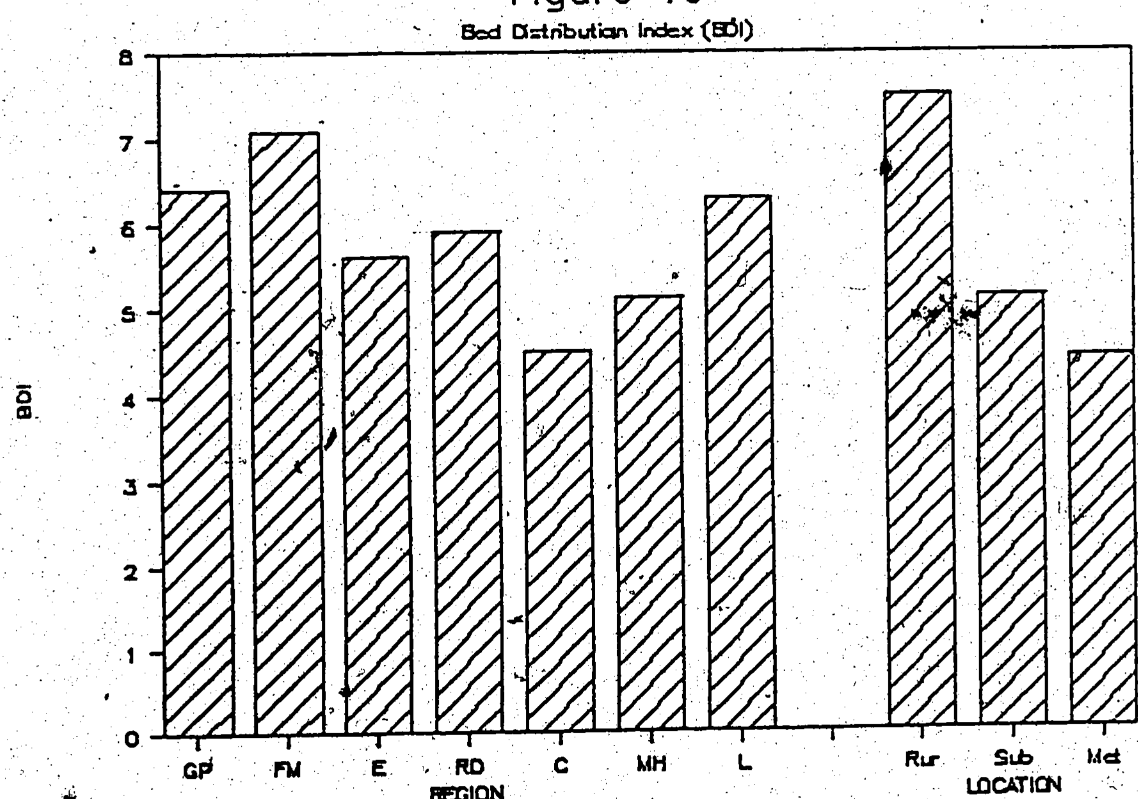


Figure 10



Medicine Hat regions were close to the provincial PDAYRATE of 1.32.

The BDI ranged from a low of 4.5 rated beds per 1,000 age-sex adjusted residents in the Calgary region to a high of 7.1 rated beds in Ft. McMurray region (see Figure 10). It is probable that the high BDI in the latter region had an influence on the respectively high USWERATE.

4.4.3 Metro-Suburban-Rural Area Analysis

To assess the role of urbanization in association with resource utilization, the GHDs were grouped into three areas: metropolitan, suburban, and rural. Six GHDs were considered to be metropolitan- Calgary GHD and metro Edmonton area including Edmonton, Leduc, Stony Plain, Fort Saskatchewan, and Sturgeon. The regional centers classified as suburban were Ft. McMurray, Grande Prairie, Red Deer, Lethbridge, and Medicine Hat. The remaining GHDs were considered to be rural.

The two types of per case rate examined, ALOS and AUSWE, are shown in Table 10. The results indicated a general decrease in both rates as the GHDs become less urbanized. The ALOS for GHDs in metro areas was 7.0 patient-days while the GHDs in rural areas demonstrated an ALOS of 6.4 patient-days. Less variation was observed with respect to AUSWE. Metropolitan areas had an AUSWE slightly above the provincial rate of 0.77 while rural areas demonstrated an AUSWE of 0.75.

The per capita rate, USWERATE, was calculated for each of the three groups (Table 10). Overall, districts in rural areas were higher than the provincial rate with a USWERATE of 0.198 while those districts considered to be metro had a low USWERATE of 0.126 (see Figure 9). This

Table 10

Area Specific Utilization Measures

Area	ALOS	AUSWE	USWE RATE	SEP RATE	PDAY RATE	BDI
Metropolitan	7.0	0.79	0.126	0.161	1.12	4.4
Suburban	6.9	0.77	0.157	0.203	1.40	5.1
Rural	6.4	0.75	0.198	0.262	1.68	7.5
PROVINCIAL	6.75	0.77	0.151	0.195	1.32	5.4

may be an attribute of the highly developed health care delivery systems in the two major urban centers - Edmonton and Calgary. It was also observed that those districts with relatively high USWERATES (rural areas) had correspondingly low per case rates. This suggested that in those centers a process of repetitive admissions of a relatively low resource intense nature was operating. Perhaps this result reflects an overuse of hospital services.

Similar trends emerged when SEPRATE and PDAYRATE were examined. While metropolitan areas generated 0.161 separations per capita, the rural areas generated 0.262. The average number of patient days generated by the province was 1.32 per capita. Again, the metropolitan areas generated less than the provincial rate (1.12 patient-days per capita) and the rural areas had a PDAYRATE of 1.68. Suburban areas generated 1.4 patient days per capita.

The BDIs for the three groups demonstrated that the rural areas had a larger number of beds per 1,000 age-sex adjusted residents than either the metro or suburban areas (see Figure 10). Often rural areas have a higher BDI to meet emergency fluctuations or demands. It is noted that the low BDI of the metro areas corresponded to a high ALOS, a high AUSWE, and a low USWERATE while the high BDI of the rural areas was associated with a low ALOS, a low AUSWE, and a high USWERATE.

4.4.4 Summary of Findings

District resource utilization variation was analyzed in three parts - GHD analysis, regional analysis, and metro-suburban-rural area analysis. The results included:

(1) ALOS ranged from 4.4 patient-days to 10.0 patient-days with a provincial rate of 6.8.

(2) AUSWE ranged from 0.66 which was experienced by two northern GHDs to a high of 1.26. It was suggested that the low rate in the north may be associated with a limited range of available services; thus, patients requiring surgical care are transferred elsewhere resulting in multiple separations for surgical cases.

(3) Vilna GHD experienced the highest USWERATE (0.537). An association between the district's high BDI and high USWERATE was suggested.

(4) The Ft. McMurray region experienced the lowest per case rate (ALOS, AUSWE) and the highest per capita rates (USWERATE, SEPRATE, PDAYRATE, BDI). The Calgary region exhibited the opposite phenomenon.

(5) The analysis of metro-suburban-rural areas resulted in similar utilization patterns to the regional analysis. The low BDI of the metro areas corresponded to a high ALOS, a high AUSWE, and a low USWERATE while the high BDI of the rural areas was associated with a low ALOS, a low AUSWE, and a high USWERATE.

4.5 Analysis of Patient Flow Patterns

As previously mentioned in section 4.1, Alberta is divided into general hospital districts (GHDs) each of which differ with respect to geographic and demographic characteristics (e.g. size, population density, and location). One important reason for analyzing patient flow patterns is to examine the relationship between the care-seeking behaviour of district residents and the geographic and demographic factors endemic to that district. Further, the availability of hospital services varies from district to district. Thus, it is important to examine physician referral patterns which unequivocally influence patient care-seeking behaviour in association with the services available in a district.

An investigation of the care-seeking behaviour patterns of Albertans was conducted from both a community-based perspective (the district of patient residence) and a provider-based perspective (the hospital in which the patient received care). In previous hospital utilization studies, both SEP (the number of separations) and PDAY (the number of patient-days) have been used as measures of resource consumption. For this study, the analyses incorporated the latter two traditional utilization indicators as well as the DRG-based USWE (weighted separations) measure. The CIs and RIs discussed in the following sections will be those calculated with the USWE utilization measure. For most of the results, the USWE-based RI and CI was found to fall in between the SEP- and PDAY-based indices. The exceptions are shown in Table 13 where a number of USWE-based indexes were equal to the PDAY-based index and in Table 12 where it is shown that USWE-based indexes tended to be either the highest or the lowest of the three indices.

For this section, active treatment hospitals were aggregated into three levels of care (see Section 4.3): tertiary, secondary, and primary. Similar to the previous section, GHDs were aggregated into: (1) metropolitan, suburban, and rural areas to reflect the location of hospital care; and (2) seven major regions of the province to reflect the influence of geographic area on patient care-seeking behaviour patterns.

4.5.1 Hospital Service Levels and Urbanization

In this section, hospitals were classified by level of care (tertiary, secondary, primary) as in section 4.3.1 and GHDs were grouped according to location (metropolitan, suburban, rural) as in section 4.4.3.

From a community-based perspective, relevance indices (RIs) were calculated (see Appendix B for method) to determine the extent to which the service population of a particular district was served by a particular hospital or hospital group. Table 11 presents the RIs for metropolitan-suburban-rural districts by patient origin and tertiary, secondary, and primary care hospitals by patient destination. When hospital destinations were classified in this manner, it was shown that, in general, the majority of patients depended on the resources of hospitals within their own districts of residence for treatment. While 55.3% of metropolitan residents depended upon resources of tertiary care facilities, a substantial percentage (37.1%) of metropolitan residents sought care in secondary hospitals. This was not an unexpected result owing to the method of hospital classification by which a number of Edmonton and Calgary hospitals were considered to be secondary facilities. Approximately 84% of the people residing in suburban districts such as Ft. McMurray, Grande Prairie, and Red Deer were served by facilities classified as secondary care hospitals. A relatively small percentage (10.7%) of suburban residents sought care in tertiary care hospitals. Most probably, this result reflected physician referrals in association with the unavailability of highly specialized treatment in secondary facilities. The tendency to leave ones district

Table 11

Relevance Indices for Level of Hospital Care

Divisions and Metro-Suburban-Rural

GHD Divisions, 1984/85

Patient Origin	Utilization Measure	Tertiary Hospitals	Secondary Hospitals	Primary Hospitals
		Patient Destination		
Metro Districts	USWE	55.3	37.1	7.6
	SEP	54.0	37.8	8.2
	PDAY	56.3	37.1	6.6
Suburban Districts	USWE	10.7	84.4	4.9
	SEP	7.4	87.2	5.4
	PDAY	11.4	84.9	3.7
Rural Districts	USWE	19.0	14.9	66.1
	SEP	13.8	12.6	73.5
	PDAY	20.1	14.6	65.4

of residence and seek hospital care elsewhere was greatest for rural residents. While 66% of those living in rural districts were served by primary care hospitals, 19% and 15% travelled to tertiary care and secondary care facilities respectively. These results were not unexpected as the availability of only primary care in rural areas would provoke a need or desire to seek more complex levels of care.

From a **provider-based** perspective, commitment indices (CIs) were calculated (see Appendix B for method) to estimate the extent to which the selected groups of hospitals allocated resources to particular districts. Table 12 presents the CIs for metropolitan, suburban, rural districts by patient origin and tertiary, secondary and primary care hospitals by patient destination. While tertiary care facilities allocated 76% of resources to residents of metropolitan areas, approximately one-fifth of total resources were committed to rural residents who do not have access to specialized treatment in primary care hospitals. A substantially smaller percentage of resources (3.5%) was committed to suburban residents. Owing to the urban location of many of the secondary care hospitals, it was not surprising that over half (53.8%) of the total resources were committed to residents of metropolitan areas. However, these hospital allocated a relatively high proportion of total resources (approximately 29% and 17% respectively) to suburban and rural residents. Primary care hospitals' resources were committed primarily to rural residents, as expected, though close to 13% of their total resources were committed to residents from metropolitan areas.

Table 12

Commitment Indices for Three Levels of Hospital Care

Divisions and Metro-Suburban-Rural

GHD Divisions, 1984/85

Patient Origin	Utilization Measure	Tertiary Hospitals	Secondary Hospitals	Primary Hospitals
		Patient Destination		
Metro Districts	USWE	76.0	53.8	12.6
	SEP	80.5	54.6	11.9
	PDAY	76.1	54.3	11.7
Suburban Districts	USWE	3.5	29.3	2.0
	SEP	2.7	30.6	1.9
	PDAY	3.7	29.8	1.6
Rural Districts	USWE	20.4	16.9	85.4
	SEP	16.8	14.8	86.2
	PDAY	20.2	15.9	86.7

4.5.2 Hospital Service Levels and Provincial Regions

As in the previous section, Alberta hospitals were aggregated into three levels of care - tertiary, secondary and primary. The GHDs in the province were aggregated into seven regions - Ft. McMurray, Grande Prairie, Edmonton, Red Deer, Calgary, Medicine Hat, and Lethbridge - as done previously in section 4.4.

From the **community-based** perspective, Table 13 presents the RIs for the seven regions by patient origin and the three levels of hospital care by patient destination. With respect to residents of regions other than Calgary and Edmonton, a larger percentage depended upon secondary hospitals for care (at least one was located in each region) than tertiary or primary care hospitals. For example, approximately 71% of Medicine Hat regional residents sought care at a secondary hospital versus 16.9% and 11.7% who sought care at primary and tertiary facilities respectively. Close to 58% of Ft. McMurray regional residents were treated in a secondary hospital versus RIs of 30.1 and 12.1 for rural and tertiary care hospitals respectively.

With regard to Calgary and Edmonton region residents, a larger percentage of the residents in the Calgary region sought care at a tertiary facility as compared to residents of the Edmonton region- 53.2% versus 39.1%. Perhaps Calgary regional residents are in need of more complex care than Edmonton regional residents and thus, are referred more often to tertiary care facilities or perhaps, the tertiary care hospitals in the Edmonton region have a more selective admission process. A comparison of the RIs for these two regions further illustrated that a larger percentage of Edmonton region residents sought

Table 13

Relevance Indices for Seven Regional Divisions

and Three Levels of Hospital Care Divisions, 1984/85

Patient Origin	Utilization Measure	Patient Destination: Tertiary Hospitals	Secondary Hospitals	Primary Hospitals
Grande Prairie	USWE	13.5	57.6	29.0
	SEP	8.9	58.7	32.4
	PDAY	14.4	57.3	28.3
Ft. McMurray	USWE	12.1	57.8	30.1
	SEP	8.1	58.5	33.4
	PDAY	12.9	63.4	23.7
Edmonton	USWE	39.1	25.7	35.1
	SEP	35.4	24.7	39.9
	PDAY	38.6	27.5	33.9
Red Deer	USWE	13.9	44.1	42.0
	SEP	9.6	42.0	48.4
	PDAY	14.4	46.3	39.3
Calgary	USWE	53.2	31.9	14.8
	SEP	51.2	32.7	16.1
	PDAY	56.9	29.1	14.1
Medicine Hat	USWE	11.7	71.4	16.9
	SEP	8.2	73.5	18.4
	PDAY	13.8	68.9	17.3
Lethbridge	USWE	9.7	49.9	40.5
	SEP	6.6	48.2	45.2
	PDAY	11.4	51.4	37.2

care from primary hospitals. This result is most probably due, however, to the inclusion of many more rural GHDs in the Edmonton region as compared to the Calgary region.

From the provider-based perspective, Table 14 presents the CIs for the seven regions and three levels of hospital care. The indices indicated that over 90% of tertiary care hospitals' resources were committed to patients from the Edmonton and Calgary regions. Both secondary and primary care facilities committed resources to each of the seven regions; however, Calgary and Edmonton regions were again the two regions to which relatively more resources were committed. Over half of primary care hospitals' resources were allocated to Edmonton region patients which was not unexpected owing to the incorporation of a number of rural GHDs in the Edmonton region.

4.5.3 Summary

The analyses of patient flow patterns in Alberta for the fiscal year 1984/85 revealed the following:

(1) The USWE-based RIs and CIs were comparable with the SEP-based and PDAY-based indices. For the most part, the indices calculated with the USWE measure fell in between the indices calculated using SEP and PDAY.

(2) In general, patients depended on the resources of hospitals within their own districts of residence. However, approximately 11% of suburban and 19% of rural residents sought care in tertiary facilities. It was suggested that these patient flow patterns may be partially attributed to the availability of more complex services in the secondary and tertiary care facilities as well as physician referral patterns.

Table 14

Commitment Indices for Seven Regional Divisions

and Three Levels of Hospital Care Divisions, 1984/85

		Patient Destination		
Patient Origin	Utilization Measure	Tertiary Hospitals	Secondary Hospitals	Primary Hospitals
Grande Prairie	USWE	1.1	5.0	2.9
	SEP	0.9	5.5	3.0
	PDAY	1.1	4.8	2.9
Ft. McMurray	USWE	0.8	4.2	2.5
	SEP	0.7	4.8	2.8
	PDAY	0.8	4.5	2.0
Edmonton	USWE	52.9	36.7	57.2
	SEP	53.0	35.7	57.7
	PDAY	49.9	38.5	57.7
Red Deer	USWE	3.1	10.3	11.2
	SEP	2.3	9.7	11.1
	PDAY	3.1	11.0	11.3
Calgary	USWE	38.7	24.5	13.0
	SEP	40.7	25.2	12.4
	PDAY	41.4	22.9	13.5
Medicine Hat	USWE	1.1	6.9	1.9
	SEP	0.8	7.2	1.8
	PDAY	1.2	6.4	1.9
Lethbridge	USWE	2.3	12.3	11.4
	SEP	1.7	11.9	11.2
	PDAY	2.4	12.0	10.6

(3) Approximately 54% of secondary care hospitals' resources were committed to residents of metro districts. However, many of the hospitals classified as secondary care facilities were located in urban areas; thus, contributing to this relatively high percentage.

(4) Tertiary care and secondary care hospitals committed 20% and 17% of total resources, respectively, to rural residents; providing the more complex care which is unavailable in primary care hospitals.

(5) About 13% of primary care resources were committed to metro residents. It is suggested that this result is due to the way in which hospitals and districts were classified. For example, while Fort Saskatchewan General Hospital District was considered to be metropolitan, Fort Saskatchewan General Hospital was classified as a primary care facility.

(6) When the province was divided into seven regions, analyses indicated that a higher percentage of Calgary region residents sought care at a tertiary facility than Edmonton region residents. This may be due to (a) physician referral practice; (b) a more selective admission process in Edmonton; or (c) the availability of alternative services in lower level of care hospitals for Edmonton region residents.

(7) As expected, a large percentage (over 90%) of tertiary care resources were committed to Edmonton and Calgary regions. Over half, 57%, of primary care hospitals' resources were allocated to Edmonton region residents. This result was most likely due to the way in which the province was divided into seven regions; Edmonton region incorporated a large number of rural GHDs.

4.6 Chapter Summary

The results from the analyses pertaining to case mix complexity and resource consumption comparisons between the U.S. and Alberta, resource utilization and allocation among hospitals ~~and general~~ hospital districts, and patient flow patterns were presented and discussed. A summary of the major findings from these analyses is presented in section 5.2 of the last chapter.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The major objectives of this study, the research strategies used to achieve those objectives, and the overall study findings are summarized in this chapter. Following an overview of this investigation, relevant conclusions are presented and recommendations are suggested.

5.1 Summary

In view of the substantial contribution of the hospital sector to health care costs and the emphasis on cost containment, the equitable allocation of scarce resources warrants investigation of hospital resource consumption. Previous studies have examined the utilization of hospital resources; however, the focus has been on measures such as the occupancy rate which manifests a fallacious picture of actual hospital utilization by a patient population.

This study, based on the service population model, was conducted in an effort to alleviate the problems associated with the aforementioned utilization studies. Later studies which have incorporated the service population model ([illegible]y and Nestman, 1980, 1984) used traditional utilization measures such as separations (SEP) and patient days (PDAY), both of which ignore the disparity in resource requirement for various disease categories. This study enlarged the service population model by incorporating a DRG (Diagnosis Related Group) based utilization measure (USWE) and by implementing the model on a micro computer.

A selective review of the literature provided an overview of research development and findings relevant to the purpose and objectives of the study. A review of the research conducted on patient flow patterns emphasized the value of origin-destination methodologies for quantitatively analyzing patient care-seeking behaviors and facilitating health care planning. A discussion of three major health care classification methodologies revealed that the DRG (Diagnosis Related Group) classification system is the most highly developed and widely applied method for directly estimating the volume and type of cases treated in a hospital, thus achieving a more accurate assessment of hospital resource consumption and/or needs. The literature revealed no cohesive theory with respect to general health services utilization. Although various conceptual models were described, there appeared to be ambiguity and misunderstanding regarding the interaction between the principle factors of need, demand, access, and utilization and the numerous societal and individual determinants. Finally, a brief overview of hospital funding revealed deficiencies in the current global funding policy which appeared to be partially alleviated by the volume-driven pilot funding project implemented by the Department of Hospitals and Medical Care (DHMC). The literature revealed that increasing per capita hospital expenditures were caused by higher costs per admission with wage rates accounting for about two thirds of the increase.

The data analyses of hospital resource allocation and utilization were conducted in four sections. Initially, the average DRG weight (which is a measure of case mix complexity) was examined in Alberta and the United States as well as the resource consumption associated with various DRG codes. Utilization rates were computed on a per case and a per capita basis for all acute care hospitals and general hospital districts to provide interhospital and interdistrict resource allocation and workload comparisons. Lastly, patient origin-destination analyses were conducted from a community-based perspective and a provider-based perspective in order to assess patient flow patterns.

5.2 Major Findings

The major findings evident from the analyses are listed below:

(1) In Alberta, approximately 41% of hospital resources were consumed by less than one-tenth of all DRG groups. This represented 44% of total separations and 45% of total patient-days. Estimated total cost for the top forty DRGs totalled 463.4 million dollars.

(2) Analyses indicated that the top three DRGs in terms of resource consumption for Alberta were: DRG 373 (Vaginal Delivery without complication or comorbidity), DRG 468 (Unrelated Operating Room Procedures), and DRG 98 (Bronchitis and Asthma, Age 0-17). Similar analyses conducted with the U.S. Medicare data indicated that cardiovascular DRGs dominated in terms of resource consumption with the top three DRGs being DRG 127 (Heart Failure and Shock), DRG 14 (Specific Cerebrovascular Disorders except Transient Ischemic Attack) and DRG 468 (Unrelated Operating Room Procedures). The ranking of DRGs with respect to resource consumption differed when relative resource requirement (DRG weight) among disease categories was ignored.

(3) The average DRG weight (AUSWE) for Alberta was 0.77 which was slightly below the U.S. theoretical average of 1.0. The average DRG

weight for the U.S. Medicare patients was 1.10.

(4) When only those persons 65 years of age and older were selected, the analyses revealed: (a) DRG 127 (Heart Failure and Shock) ranked number one in terms of resource consumption in both Alberta and the U.S.; and (b) the average DRG weight for Alberta increased to 1.03 indicating the more resource intensive nature of morbidity experienced by the older group. The average DRG weight for U.S. Medicare patients stayed relatively stable at 1.11.

(5) With respect to the geometric mean length of stay (GMLOS), selected DRGs (Diagnosis Related Groups) were compared between the U.S. and Alberta. Out of the top forty DRGs eighteen were able to be compared and thirteen of the eighteen DRGs had a GMLOS which was higher in Alberta than the U.S.

(6) Average DRG weight (AUSWE) and average length of stay (ALOS) measures displayed a direct relationship with hospital size (small, medium, large and healthcenter), level of care (primary, secondary and tertiary) and hospital location (rural, regional and metropolitan). Regression analysis indicated that average DRG weight as measured by AUSWE explained about 70% of per case cost variation among Alberta hospitals.

(7) The USWERATE (number of weighted separations per capita) typically declined as hospital size increased (small: 0.185; healthcenter: 0.137), as level of care increased (primary care: 0.179; tertiary care: 0.137) and for hospitals located in metropolitan areas (rural: 0.185; metro: 0.135). Cost per capita (COSTRATE) was highest for tertiary care facilities, 613.5 dollars per capita, and when hospitals were classified

by size, an inverse relationship between size and cost was manifest. The service population index (SPI=number of persons served per bed) ranged from 42.5 persons served per bed to 282.8 persons per hospital bed. The SPI for medium-sized hospitals was higher than that for large hospitals.

(8) With regard to regional resource utilization variation, the northern region of Ft. McMurray was associated with low per case rates such as average length of stay (ALOS = 5.9 patient days) and average DRG weight (AUSWE = 0.68) and high per capita rates such as number of weighted separations per capita (USWERATE = 0.233) or number of beds per 1,000 age-sex adjusted residents (BDI = 7.1). Conversely, Calgary region exhibited high per case rates (ALOS = 7.1 patient days; AUSWE = 0.78) and low per capita rates (USWERATE = 0.126; BDI = 4.5).

(9) Variation in per case and per capita measures was evident when districts were classified according to area (rural, suburban, metropolitan). Metro areas were characterized by a low bed distribution index (BDI = 4.4) and USWERATE (number of weighted separations per capita = 0.126) and a high average length of stay (ALOS = 7.0 patient days) and average DRG weight (AUSWE = 0.79) while the high BDI (7.5 beds per 1,000 age-sex adjusted residents) and USWERATE (0.198) of the rural areas was associated with a low ALOS (6.4 patient days) and AUSWE (0.75). It was found that rural people consumed 36% more resources per person than their metro counterparts.

(10) Patient origin-destination analyses indicated that about 13% and 57% of primary care resources were committed to metro residents and Edmonton region residents, respectively.

(11) Analyses showed that a higher percentage of Calgary region residents (53%) sought care from a tertiary care facility than Edmonton region residents (39%).

(12) The Relevance and Commitment indices computed using the USWE (weighted separation) measure were comparable to those indices calculated using either SEP (separations) or PDAY (patient days).

5.3 Conclusions

The primary purpose of this study was to explore the allocation and utilization of hospital resources in Alberta using the service population model, DRG data, and the software available for a microcomputer. In light of these objectives and the research findings of this investigation, the following conclusions were made:

(1) Population based resource allocation and utilization measures were derived using the DRG based hospital service population model.

(2) The service population model was implemented on a micro computer using software which included Lotus 1-2-3 and SPSS/PC.

(3) The relatively low average DRG weight (0.77) found in Alberta as compared to the U.S. theoretical average of 1.0 may indicate: (a) less restrictive admission criteria in Alberta hospitals; (b) on the whole, the Alberta population is less severely ill than the U.S. population. Neither of the above would seem to be as likely as (c) the type of health care system in the U.S., and in particular the economic factors which may prevent patients from seeking care for illnesses of low severity. On the other hand, the expectations and attitudes of the American patient are such that he seeks out the newest and often most

expensive forms of diagnosis and treatment with which his physician concurs because of the high incidence of malpractice suits. This may lead to an abnormally high average DRG weight in that country.

(4) The lower geometric mean length of stay exhibited in the U.S. for thirteen of eighteen selected DRGs (Diagnosis Related Group) as compared to Alberta most probably reflected the difference in health care systems. The prospective reimbursement scheme in the U.S. may lead to an early discharge whereas no similar pressure exists in the Canadian health care system.

(5) High per capita utilization rates, in terms of the USWERATE, SEPRATE (separations per capita), and PDAYRATE (patient days per capita), in conjunction with relatively low resource needs for the average case as measured by ALOS (average length of stay) and AUSWE (average DRG weight), appeared to be characteristic of small, primary care, or rurally located hospitals; in contrast, low per capita utilization rates, in conjunction with comparatively high per case resource requirements, were associated with health care facilities which could offer all levels of care and alternative health care delivery services (healthcenters, tertiary care, metropolitan location). It would seem that a process of repetitive admissions of a low resource nature was operative in the former types of hospitals, while a selective admission process increasingly biased toward more complex cases was occurring in the latter hospitals.

(6) Rural areas characterized by a high BDI (number of beds per 1,000 age-sex adjusted residents) were also characterized by high per capita rates (USWERATE, PDAYRATE, SEPRATE) and low per case rates (ALOS and

AUSWE); in contrast, metro areas characterized by a low BDI were associated with low per capita rates and high per case rates. It would seem that the BDI had an influence on the utilization of hospital services. Other studies (Roemer, 1961; Anderson, 1973a; Canoodt & Knickman, 1984) have also reported this effect. In addition, the unavailability of community services in the rural areas and in some instances the difficulties in transportation back and forth for medical care may lead to increased hospitalization for rural residents.

(7) It was expected that the service population indices (SPIs) for small, primary care and rurally located hospitals would be relatively lower owing to the need to meet fluctuating emergency or urgent demands. The higher SPI obtained for medium hospitals versus large hospitals implied that the former facilities are relatively more efficient or that they are relatively overloaded. The inverse relationship exhibited between cost per capita (COSTRATE) and hospital size was postulated to be due to economies of scale.

(8) With regard to the major findings reported on patient flow patterns, it is postulated that the patterns of patient travel for hospital care and the patterns of resource commitment by hospitals and hospital groups likely reflected physician referral patterns, hospital size and the care available in different facilities, the major travel routes in the province, factors unique to individual patients, and the way in which hospitals and general hospital districts were classified.

5.4 Recommendations

Recommendations based on the major findings and conclusions of this study are provided as follows:

(1) Policies directed toward reducing high utilization rates (including the BDI) should be incorporated on a provincial-wide basis owing to the high utilization rates generated in numerous rural hospitals spanning a broad geographic area.

(2) Using the service population model a similar study involving data from a number of years could be conducted so that (a) resource allocation and utilization trends could be examined; and (b) stability of service population could be tested. Unless such stability is evident, the service population model may be of limited use for hospital planners.

(3) To assess the performance of Alberta with respect to hospital resource allocation and utilization, comparisons should be made with other Canadian provinces using the service population model. Additional worthwhile information might be obtained from a similar examination in another developed country.

(4) A similar study should be conducted which incorporates SEP (number of separations), PDAY (number of patient days) and USWE (DRG based weighted separations) in the service population model to fully examine the benefit of the weighted utilization measure.

(5) Further studies using the service population model should be implemented on a micro computer to refine the methodology and facilitate its application to hospital resource planning.

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APPENDIX A

RESULTS SUPPLEMENT

APPENDIX A.1

Listing of Major Diagnostic Categories and Corresponding Utilization Measures, 1984/85

MDC	Description	Alberta SEPS	Alberta SEPS%	Alberta RANK	Alberta USWE	Alberta USWE%	Alberta RANK	United States SEPS	United States SEPS%	United States RANK	United States USWE	United States USWE%	United States RANK
1	Diseases and Disorders of the Nervous System	17954	4.1	9	16552.62	4.9	8	898227	8.3	5	983098.79	8.3	5
2	Diseases and Disorders of the Eye	7515	1.7	16	3901.81	1.2	21	513212	4.8	7	293030.22	2.5	11
3	Diseases and Disorders of the Ear, Nose, and Throat	27139	6.2	7	12769.75	3.8	10	178150	1.7	15	114422.76	1.0	18
4	Diseases and Disorders of the Respiratory System	31154	7.1	5	29108.00	8.6	4	1228360	11.4	3	1455626.62	12.2	2
5	Diseases and Disorders of the Circulatory System	29463	6.7	6	34650.23	10.3	3	2419630	22.4	1	3006583.58	25.3	1
6	Diseases and Disorders of the Digestive System	52145	11.9	2	41932.24	12.4	1	1363201	12.6	2	1438126.77	12.1	3
7	Diseases and Disorders of the Hepatobiliary System and Pancreas	10201	2.3	13	13495.92	4.0	9	321252	3.0	10	445887.60	3.8	7
8	Diseases and Disorders of the Musculo-skeletal System and Connective Tissue	39492	9.0	4	34963.00	10.4	2	1027836	9.5	4	1243860.35	10.5	4
9	Diseases and Disorders of the Skin, Subcutaneous Tissue and Breast	15522	3.6	10	10445.57	3.1	12	330261	3.1	9	309316.11	2.6	9
10	Endocrine, Nutritional and Metabolic Diseases and Disorders	8235	1.9	15	7659.89	2.3	15	346111	3.2	8	294487.20	2.5	10
11	Diseases and Disorders of the Kidney and Urinary Tract	12282	2.8	11	10182.26	3.0	14	524534	4.9	6	536026.25	4.5	6
12	Diseases and Disorders of the Male Reproductive System	7022	1.6	17	5268.46	1.6	17	306051	2.8	11	277046.29	2.3	12
13	Diseases and Disorders of the Female Reproductive System	24597	5.6	8	19512.73	5.8	6	149047	1.4	16	140738.68	1.2	17
14	Pregnancy, Childbirth and the Puerperium System	63623	14.5	1	27712.89	8.2	5	3437	.0	23	1674.73	.0	23
15	Newborns and Other Neonates with Conditions Originating in the Perinatal Period	44118	10.1	3	18153.71	5.4	7	751	0.0	24	565.14	0.0	24
16	Diseases and Disorders of the Blood and Blood-Forming Organs and Immunological Disorders	2415	0.6	23	2106.53	0.6	23	120913	1.1	19	98069.95	0.8	19
17	Myeloproliferative Diseases and Disorders and Poorly Differentiated Neoplasms	3356	0.8	21	3921.75	1.2	20	217398	2.0	13	220286.64	1.9	13
18	Infectious and Parasitic Diseases (Systemic or Unspecified Sites)	3552	0.8	20	3767.84	1.1	22	129374	1.2	18	193347.23	1.6	14
19	Mental Diseases and Disorders	11347	2.6	12	10234.04	3.0	13	194088	1.8	14	185621.90	1.6	15
20	Substance Use and Substance Induced Organic Mental Disorders	3281	0.8	22	4314.55	1.3	19	42431	0.4	21	33258.16	0.3	21
21	Injuries, Poisonings and Toxic Effects of Drugs	8828	2.0	14	7160.13	2.1	16	145693	1.4	17	151869.99	1.3	16
22	Burns	1029	0.2	24	2001.02	0.6	24	6837	0.1	22	15107.13	0.1	22
23	Factors Influencing Health Status and Contacts with Health Services	6501	1.5	19	4992.40	1.5	18	60241	0.6	20	51236.56	0.4	20
*24		6949	1.6	18	12682.79	3.8	11	269148	2.5	12	401953.86	3.4	8
TOTAL		437620	100.0		337490.1	100.0		10794183	100.0		11891248.51	100.0	

* includes DRGs 468 through 500 which are undefined procedures

APPENDIX A.2

Utilization Measures for General Hospitals in Alberta, 1984/85

HOSPITAL CODE	BED	SEP	PDAY	USWE	ALOS	AUSWE	COST *	SP(Avg)	SPI	SEP RATE	PDAY RATE	USWE RATE
1	30	1476	8248	958	5.6	0.65	2207.4	4570	152.3	0.323	1.80	0.210
2	46	826	4046	555	4.9	0.67	2448.1	4649	101.1	0.178	0.87	0.119
3	83	2362	12680	1591	5.4	0.67	4278.6	12644	152.3	0.187	1.00	0.126
4	30	794	4476	539	5.6	0.68	1269.3	3849	128.3	0.206	1.16	0.140
5	30	766	4818	533	6.3	0.70	1230.2	3397	113.2	0.225	1.42	0.157
6	30	978	5039	629	5.2	0.64	1491.4	3819	127.3	0.256	1.32	0.165
7	10	475	1893	294	4.0	0.62	752.8	1510	151.0	0.315	1.25	0.194
9	41	1099	8581	814	7.8	0.74	2950.9	5382	131.3	0.204	1.59	0.151
10	60	1687	8952	1085	5.3	0.64	2816.4	4629	77.2	0.364	1.93	0.234
11	19	563	3371	365	6.0	0.65	938.4	2492	131.1	0.226	1.35	0.147
12	30	644	4151	462	6.4	0.72	1210.0	2001	66.7	0.322	2.07	0.231
13	30	689	4218	489	6.1	0.71	1138.6	3406	113.5	0.202	1.24	0.143
14	70	2620	15825	1745	6.0	0.67	4618.6	10162	145.2	0.258	1.56	0.172
15	128	5255	28786	3952	5.5	0.75	35790.9	30012	234.5	0.175	0.96	0.132
16	816	29326	248234	25573	8.5	0.87	86631.3	193887	237.6	0.151	1.28	0.132
17	914	29265	239210	23600	8.2	0.81	89509.9	204544	223.8	0.143	1.17	0.115
18	100	7028	30968	3873	4.4	0.55	9019.5	28280	282.8	0.249	1.10	0.137
19	532	22757	152167	18671	6.7	0.82	47012.7	138409	260.2	0.164	1.10	0.135
20	194	7835	53932	6893	6.9	0.88	23416.8	52120	268.7	0.150	1.03	0.132
21	117	4194	26471	3037	6.3	0.72	6096.2	20239	173.0	0.207	1.31	0.150
22	49	1227	6715	842	5.5	0.69	2104.[illegible]	[illegible]212	126.8	0.198	1.08	0.136
23	60	3215	13516	2346	4.2	0.73	3755.[illegible]	8186	136.4	0.393	1.65	0.287
24	16	44	393	79	8.9	1.79	528.9	1119	69.9	0.039	0.35	0.070
25	30	1091	5914	738	5.4	0.68	1357.8	3117	103.9	0.350	1.90	0.237
26	9	31	288	63	9.3	2.05	440.6	441	49.0	0.070	0.65	0.144
27	43	1347	7797	973	5.8	0.72	2003.2	5899	137.2	0.228	1.32	0.165
28	25	866	3985	583	4.6	0.67	1245.5	4303	172.1	0.201	0.93	0.135
29	45	1853	8873	1152	4.8	0.62	2279.9	4503	100.1	0.412	1.97	0.256
30	20	483	2489	347	5.2	0.72	1158.7	1728	86.4	0.280	1.44	0.201
31	25	626	3718	432	5.9	0.69	1408.5	2133	85.3	0.294	1.74	0.203
32	30	1427	8965	987	6.3	0.69	1823.7	4299	143.3	0.332	2.09	0.229
33	25	831	4314	881	5.2	1.06	1891.4	5174	207.0	0.161	0.83	0.170
34	50	1533	9013	1110	5.9	0.72	2014.8	7315	146.3	0.210	1.23	0.152
35	50	2248	12121	1472	5.4	0.65	3583.7	7836	156.7	0.287	1.55	0.188
36	70	2449	14071	1642	5.7	0.67	4197.5	10205	145.8	0.240	1.38	0.161
37	26	759	5127	525	6.8	0.69	1359.8	4431	170.0	0.172	1.16	0.119
38	76	2274	21794	2288	9.6	1.01	33012.6	15135	199.1	0.150	1.44	0.151
39	589	19100	156563	16492	8.2	0.86	44024.1	122259	207.6	0.156	1.28	0.135
41	558	21919	158752	17218	7.2	0.79	44317.0	121963	218.6	0.180	1.30	0.141
43	933	45963	289572	35326	6.3	0.77	89574.9	224184	240.3	0.205	1.29	0.158
44	1196	30547	274092	30899	9.0	1.01	121606.7	220426	184.3	0.139	1.24	0.140
45	51	1602	7938	1047	5.0	0.65	2214.2	7057	138.4	0.227	1.12	0.148
46	32	1032	6601	636	6.4	0.62	2372.0	3881	121.3	0.266	1.70	0.164
47	10	271	1605	336	5.9	1.24	72[illegible].3	1638	163.8	0.165	0.98	0.205
48	10	32	634	108	19.8	3.38	6[illegible].0	755	75.5	0.042	0.84	0.143
49	50	2231	10943	1461	4.9	0.65	29[illegible].6	5982	119.6	0.373	1.83	0.244

APPENDIX A.2 (continued)

HOSPITAL CODE	BED	SEP	PDAY	USWE	ALOS	AUSWE	COST *	SP(Avg)	SPI	SEP RATE	PDAY RATE	USWE RATE
50	32	1184	6724	830	5.7	0.70	1826.3	3816	119.3	0.310	1.76	0.217
52	50	2327	11234	1531	4.8	0.66	2648.9	10071	201.4	0.231	1.12	0.152
53	36	2030	9861	1256	4.9	0.62	2092.4	3870	107.5	0.525	2.55	0.325
54	40	484	3767	361	7.8	0.75	1261.6	2750	68.7	0.176	1.37	0.131
55	12	257	1190	189	4.6	0.74	871.9	1288	107.3	0.200	0.92	0.147
56	191	8466	50200	6038	5.9	0.71	18329.0	33690	176.4	0.251	1.49	0.179
57	50	1482	8012	995	5.4	0.67	2465.8	5050	101.0	0.293	1.59	0.197
58	20	582	4904	388	8.4	0.67	1273.2	1844	92.2	0.316	2.66	0.210
59	75	3105	18138	2097	5.8	0.68	4612.2	6642	88.6	0.467	2.73	0.316
60	65	2751	14478	1764	5.3	0.64	5686.3	10635	163[illegible]6	0.259	1.36	0.166
61	40	1843	8245	1182	4.5	0.64	2911.5	5802	14[illegible]	0.318	1.42	0.204
62	10	372	2424	273	6.5	0.73	881.3	1411	141.[illegible]	0.264	1.72	0.193
63	35	2220	11183	1486	5.0	0.67	2515.8	7518	214.[illegible]	0.295	1.49	0.198
64	8	232	1024	167	4.4	0.72	562.4	2203	275.[illegible]	0.105	0.46	0.076
65	33	635	2848	418	4.5	0.66	1523.3	3261	98.[illegible]	0.195	0.87	0.128
66	30	880	6508	566	7.4	0.64	1343.3	2703	90.1	0.326	2.41	0.209
67	72	3442	17628	2256	5.1	0.66	4498.0	6524	90.6	0.528	2.70	0.346
68	50	1483	8697	952	5.9	0.64	2823.4	6478	129.6	0.229	1.[illegible]	0.147
69	48	982	6606	708	6.7	0.72	2300.4	5015	104.5	0.196	[illegible]	0.141
70	35	1648	7924	1111	4.8	0.67	2245.8	7470	213.4	0.221	[illegible]	0.149
71	205	8628	62232	6641	7.2	0.77	14962.6	38061	185.7	0.227	[illegible]	[illegible].17[illegible]
72	202	8543	56758	6976	6.6	0.82	13617.5	40111	198.6	0.213	[illegible]	[illegible]74
74	61	2023	13529	1362	6.7	0.67	3374.3	5572	91.3	0.363	[illegible]	[illegible]44
75	26	1073	4949	688	4.6	0.64	1092.7	3126	120.2	0.343	[illegible]	[illegible]220
76	34	772	3958	498	5.1	0.65	1561.1	2919	85.8	0.265	[illegible]	0.171
77	20	397	2826	299	7.1	0.75	1501.1	2413	120.6	0.165	1.17	0.124
78	22	468	2938	340	6.3	0.73	938.7	2363	107.4	0.198	1.24	0.144
79	237	10716	64871	7859	6.4	0.73	16374.7	50170	211.7	0.214	1.29	0.157
80	27	454	2680	332	5.9	0.73	979.9	2054	76.1	0.221	1.30	0.162
81	10	191	1790	154	9.4	0.80	734.6	993	99.3	0.192	1.80	0.155
82	20	369	4029	262	10.9	0.71	887.7	1400	70.0	0.264	2.88	0.187
83	43	1659	9403	1084	5.7	0.65	2112.7	6865	159.7	0.242	1.37	0.158
84	31	459	2956	302	6.4	0.66	1221.5	2080	67.1	0.221	1.42	0.145
85	71	3095	16600	1936	5.4	0.63	4227.6	9251	130.3	0.335	1.79	0.209
86	25	622	3014	415	4.8	0.67	943.3	3136	125.4	0.198	0.96	0.132
87	42	2311	10515	1587	4.5	0.69	3346.8	6338	150.9	0.365	1.66	0.250
88	50	2430	12212	1594	5.0	0.66	2828.0	7053	141.1	0.345	1.73	0.226
89	31	1409	6855	923	4.9	0.66	1993.4	4386	141.5	0.321	1.56	0.210
91	25	1200	6644	809	5.5	0.67	1674.5	3840	153.6	0.312	1.73	0.211
92	349	14226	111042	11458	7.8	0.81	35123.0	71564	205.1	0.199	1.55	0.160
93	26	907	6857	623	7.6	0.69	1386.3	3656	140.6	0.248	1.88	0.171
94	57	1698	9365	1101	5.5	0.65	2410.0	7225	126.8	0.235	1.30	0.152
95	25	561	3945	384	7.0	0.69	1275.7	2426	97.0	0.231	1.63	0.159
96	42	1242	6899	815	5.6	0.66	2011.2	4856	115.6	0.256	1.42	0.168
97	50	2149	12694	1435	5.9	0.67	3224.7	7837	156.7	0.274	1.62	0.183

APPENDIX A.2 (continued)

HOSPITAL CODE	BED	SEP	PDAY	USWE	ALOS	AUSWE	COST *	SP(Avg)	SPI	SEP RATE	PDAY RATE	USWE RATE
98	27	1498	6920	961	4.6	0.64	2344.7	6242	231.2	0.240	1.11	0.154
99	75	2399	13539	1519	5.6	0.63	3715.5	7390	98.5	0.325	1.83	0.206
100	66	2129	12460	1508	5.9	0.71	3836.3	8800	133.3	0.242	1.42	0.171
101	25	834	4633	529	5.6	0.63	1362.6	3495	139.8	0.239	1.33	0.151
102	31	1153	9167	830	8.0	0.72	1816.9	4339	140.0	0.266	2.11	0.191
103	15	207	1962	160	9.5	0.77	1240.9	1637	109.1	0.126	1.20	0.098
105	37	1623	8330	1131	5.1	0.70	1744.7	3694	99.8	0.439	2.25	0.306
106	35	1606	8453	1022	5.3	0.64	2448.6	3300	94.3	0.487	2.56	0.310
107	70	2027	15173	1428	7.5	0.70	3620.7	8106	115.8	0.250	1.87	0.176
108	39	1811	9835	1183	5.4	0.65	3523.8	7277	186.6	0.249	1.35	0.163
109	32	1366	9171	930	6.7	0.68	2207.3	4420	138.1	0.309	2.08	0.210
110	17	273	2984	204	10.9	0.75	973.2	589	34.7	0.463	5.07	0.346
111	25	845	5720	597	6.8	0.71	1526.2	3540	141.6	0.239	1.62	0.169
112	49	1499	9652	987	6.4	0.66	2455.9	5880	120.0	0.255	1.64	0.168
113	80	2723	18187	1890	6.7	0.69	3712.8	11869	148.4	0.229	1.53	0.159
114	135	6663	38168	4405	5.7	0.66	8807.1	16311	120.8	0.408	2.34	0.270
115	25	461	4218	351	9.1	0.76	1033.3	2314	92.5	0.199	1.82	0.152
116	34	1417	5307	842	3.7	0.59	1834.5	4917	144.6	0.288	1.08	0.171
117	142	6297	39007	4102	6.2	0.65	16912.9	20774	146.3	0.303	1.88	0.197
118	39	2189	9120	1284	4.2	0.59	1904.0	4932	126.5	0.444	1.85	0.260
119	34	1132	5167	760	4.6	0.67	1403.4	3452	101.5	0.328	1.50	0.220
120	100	5579	29086	3863	5.2	0.69	8180.8	27178	271.8	0.205	1.07	0.142
121	34	694	2864	430	4.1	0.62	1093.5	3057	89.9	0.227	0.94	0.141
122	32	1142	7364	863	6.4	0.76	1684.3	5075	158.6	0.225	1.45	0.170
123	25	2025	6800	1222	3.4	0.60	1773.5	3421	136.8	0.592	1.99	0.357
125	365	11730	80256	8949	6.8	0.76	26301.9	67738	185.6	0.174	1.18	0.132
126	194	3630	32291	3274	8.9	0.90	12412.5	36267	186.9	0.100	0.89	0.090
132	25	687	3226	457	4.7	0.66	958.0	2212	88.5	0.311	1.46	0.206
133	10	249	674	163	2.7	0.65	718.1	1219	121.9	0.204	0.55	0.134
134	25	60	237	55	4.0	0.91	358.2	2837	113.5	0.021	0.08	0.019
301	29	533	3615	393	6.8	0.74	202.6	1225	42.2	0.435	2.95	0.321
302	50	899	3275	738	3.6	0.82	644.4	3796	75.9	0.237	0.86	0.194
501	18	533	3617	709	6.8	1.33	912.5	2049	113.9	0.260	1.76	0.346
TOTAL	11990	437620	2953493	337820	6.75	0.772	1003508.6	2237257	186.6	0.196	1.32	0.151

APPENDIX A.3

District Specific Utilization Measures, 1984/85

NAME	CODE	SP	SEP	PDAY	USWE	BED	BDI	SEP RATE	PDAY RATE	USWE RATE	ALOS	AUSWE
Mannvile MHD	1	3453.1	670	4865	519	25	7.3	0.194	1.41	0.150	7.3	0.77
Vermilion MHD	2	7285.4	1795	11904	1385	46	6.3	0.246	1.63	0.190	6.6	0.77
Drumheller GHD	3	12990.3	2743	18913	2140	83	6.4	0.211	1.46	0.165	6.9	0.78
Islay MHD	4	1883.0	288	1524	226	9	4.9	0.153	0.81	0.120	5.3	0.78
Cardston MHD	5	7397.0	2247	12190	1765	47	6.4	0.304	1.65	0.239	5.4	0.79
Bassano MHD	6	5683.5	1510	9601	1082	48	8.4	0.266	1.69	0.190	6.4	0.72
Lloydminister MHD	8	14397.3	922	6360	853	53	3.7	0.064	0.44	0.059	6.9	0.93
Hanna GHD	9	7073.3	2015	13262	1522	64	9.0	0.285	1.87	0.215	6.6	0.76
Viking MHD	10	4561.8	1201	8907	963	32	7.0	0.263	1.95	0.211	7.4	0.80
High River GHD	11	16819.1	4085	25624	3013	97	5.8	0.243	1.52	0.179	6.3	0.74
Provost GH & NHD	12	4487.5	1266	7146	931	30	6.7	0.282	1.59	0.207	5.6	0.74
Athabasca MHD	13	8161.0	2128	14488	1601	52	6.3	0.261	1.78	0.196	6.8	0.75
Grande Prairie GHD	14	35369.1	7958	49635	5814	193	5.5	0.225	1.40	0.164	6.2	0.73
Red Deer MHD	15	58958.1	1033[illegible]	80039	8272	272	4.6	0.175	1.36	0.140	7.7	0.80
Innisfail MHD	16	13369.0	3132	20141	2462	65	4.9	0.234	1.51	0.184	6.4	0.79
Wainwright GHD	17	9588.4	2397	16597	1786	74	7.7	0.250	1.73	0.186	6.9	0.75
Elk Point MHD	18	4982.8	1101	7578	779	36	7.3	0.221	1.52	0.156	6.9	0.71
Vulcan MHD	19	5165.6	1103	7984	869	33	6.5	0.214	1.55	0.168	7.2	0.79
Stettler GHD	20	12802.1	2968	19331	2263	80	6.2	0.232	1.51	0.177	6.5	0.76
Peace River MHD	21	9698.1	2567	16263	1867	68	7.0	0.265	1.68	0.193	6.3	0.73
Consort AHD	22	2846.5	837	4860	648	30	10.4	0.294	1.71	0.228	5.8	0.77
Myrnam MHD	23	1611.9	522	5222	406	22	13.5	0.324	3.24	0.252	10.0	0.78
Claresholm GHD	24	7211.4	1552	10179	1249	49	6.8	0.215	1.41	0.173	6.6	0.80
Little Bow MHD	25	1214.5	331	2076	300	16	13.1	0.273	1.71	0.247	6.3	0.91
Olds MHD	26	9287.8	1914	13557	1451	54	5.8	0.206	1.46	0.156	7.1	0.76
Taber MHD	27	13301.0	3226	20442	2465	92	6.9	0.243	1.54	0.185	6.3	0.76
Brooks GHD	28	14227.2	3456	21650	2519	90	6.4	0.243	1.52	0.177	6.3	0.73
Magrath MHD	29	3621.8	1143	6083	843	28	7.8	0.316	1.68	0.233	5.3	0.74
Eckville MHD	30	4901.9	794	5998	624	27	5.5	0.162	1.22	0.127	7.6	0.79
Raymond MHD	31	5293.5	1603	9562	1158	34	6.4	0.303	1.81	0.219	6.0	0.72
Beaverlodge-Hytbe	32	7084.0	1783	11229	1333	51	7.3	0.252	1.59	0.188	6.3	0.75
Didsbury MHD	33	9957.0	2254	14556	1737	66	6.6	0.226	1.46	0.174	6.5	0.77
Vegreville GHD	34	10087.9	2433	18775	1926	80	7.9	0.241	1.86	0.191	7.7	0.79
Oyen MHD	35	2297.3	558	4218	425	29	12.8	0.243	1.84	0.185	7.6	0.76
St. Paul GHD	36	10817.8	2691	17569	2007	90	8.4	0.249	1.62	0.185	6.5	0.75
Ponoka GH & MHD	37	11071.9	2881	19231	2321	73	6.6	0.260	1.74	0.210	6.7	0.81
Mayerthorpe GHD	38	5223.6	1149	8170	929	41	7.9	0.220	1.56	0.178	7.1	0.81
Coronation MHD	39	2663.3	855	5227	623	29	10.8	0.321	1.96	[illegible]34	6.1	0.73
Crowsnest Pass GHD	40	8657.1	1705	13677	1445	60	6.9	0.197	1.60	0.167	8.1	0.85

APPENDIX A.3 (continued)

NAME	CODE	SP	SEP	PDAY	USWE	BED	BDI	SEP RATE	PDAY RATE	USWE RATE	ALOS	AUSWE
Castor MHD	41	3211.3	1089	6858	812	30	9.4	0.339	2.14	0.253	6.3	0.75
Two Hills MHD	42	3858.8	955	6822	788	29	7.5	0.247	1.77	0.204	7.1	0.83
Bentrey MHD	43	2173.3	570	3283	452	14	6.3	0.262	1.51	0.208	5.8	0.79
Elnora MHD	44	1690.0	319	2759	401	11	6.7	0.189	1.63	0.237	8.6	1.26
Three Hills MHD	45	6410.8	1393	9232	1069	42	6.5	0.217	1.44	0.167	6.6	0.77
Cereal MHD	46	799.6	193	1234	173	13	16.8	0.241	1.54	0.217	6.4	0.90
Tofield MHD	47	6944.3	1824	15105	1432	49	7.0	0.263	2.18	0.206	8.3	0.79
Macleod MHD	48	6730.3	1691	11783	1359	46	6.9	0.251	1.75	0.202	7.0	0.80
Rocky Mt. House MHD	49	11599.3	2689	18006	2027	83	7.2	0.232	1.55	0.175	6.7	0.75
Berwyn MHD	50	4383.6	1497	8546	1092	43	9.7	0.341	1.95	0.249	5.7	0.73
Sundre GHD	51	4330.4	1425	7945	1083	40	9.3	0.329	1.83	0.250	5.6	0.76
Rimbey MHD	52	5942.3	1375	10715	1080	39	6.5	0.231	1.80	0.182	7.8	0.79
Empress MHD	53	153[illegible]	259	2146	265	18	11.6	0.169	1.40	0.173	8.3	1.02
Lacombe GHD	54	1399[illegible]	3052	21498	2407	92	6.6	0.218	1.54	0.172	7.0	0.79
Flagstaff-Hughenden	55	12703.7	3875	29527	2880	131	10.3	0.305	2.32	0.227	7.6	0.74
Trochu MHD	56	2148.6	332	2766	284	16	7.5	0.155	1.29	0.132	8.3	0.86
Glendon MHD	57	2102.5	430	3139	360	18	8.3	0.205	1.49	0.171	7.3	0.84
Fairview MHD	59	8211.0	2785	15284	2029	65	7.9	0.339	1.86	0.247	5.5	0.73
Spirit River GHD	60	7560.7	1824	11662	1383	60	7.9	0.241	1.54	0.183	6.4	0.76
Boyle GHD	61	3247.5	1311	8531	999	42	12.9	0.404	2.63	0.308	6.5	0.76
Grande Cche GHD	63	3709.9	867	3982	581	38	10.4	0.234	1.07	0.157	4.6	0.67
Lamont-M-W GHD	64	12093.6	2690	21340	2189	108	8.9	0.222	[illegible]	0.181	7.9	0.81
Lethbridge GHD	65	78393.3	15309	108350	12307	399	5.1	0.195	1.38	0.157	7.1	0.80
Turner Valley MHD	66	5089.4	510	3443	421	17	3.4	0.100	0.68	0.083	6.8	0.82
Barrhead GHD	67	15320.9	2594	7058	2024	95	6.2	0.169	1.11	0.132	6.6	0.78
Medcine Hat GHD	69	55313.6	10677	70085	8366	257	4.6	0.193	1.27	0.151	6.6	0.78
Manning MHD	70	4214.2	1244	7002	856	44	10.4	0.295	1.66	0.203	5.6	0.69
Banff GHD	71	4436.9	904	5720	683	43	9.6	0.204	1.29	0.154	6.3	0.76
Bow Island GHD	72	4649.4	1037	6714	794	31	6.7	0.223	1.44	0.171	6.5	0.77
Smoky Lake MHD	73	4454.5	918	7538	772	36	8.1	0.206	1.69	0.173	8.2	0.84
Cold Lake GHD	75	10609.5	3422	17479	2536	115	10.8	0.323	1.65	0.239	5.1	0.74
Hinton GHD	76	7568.2	2146	11440	1564	51	6.7	0.284	1.51	0.207	5.3	0.73
Drayton Valley MHD	77	13098.9	3289	20718	2479	79	6.1	0.251	1.58	0.189	6.3	0.75
Lac La Biche GHD	78	7342.8	3618	20646	2545	75	10.3	0.493	2.81	0.347	5.7	0.70
Pincher Creek GHD	79	8868.2	2931	15708	2198	58	6.6	0.331	1.77	0.248	5.4	0.75
Canmore MHD	80	4467.2	1167	7441	880	40	9.0	0.261	1.67	0.197	6.4	0.75
Wetaskiwin MHD	81	22307.4	8736	53421	6127	179	8.0	0.392	2.39	0.275	6.1	0.70
Picture Butte MHD	82	1805.5	466	3163	347	15	8.4	0.258	1.75	0.192	6.8	0.74
Leduc GHD	83	25126.8	4449	27609	3434	121	4.8	0.177	1.10	0.137	6.2	0.77

APPENDIX A.3 (continued)

NAME	CODE	SP	SEP	PDAY	USWE	BED	BDI	SEP RATE	PDAY RATE	USWE RATE	ALOS	AUSWE
Stony Plain MHD	84	40185.7	7442	45628	5681	187	4.7	0.185	1.14	0.141	6.1	0.76
Breton GHD	85	7639.2	1677	11876	1351	58	7.5	0.220	1.55	0.177	7.1	0.81
Edson GHD	86	12041.3	2672	15584	1983	79	6.6	0.222	1.29	0.165	5.8	0.74
Jasper GHD	87	3257.6	691	3835	517	33	10.0	0.212	1.18	0.159	5.5	0.75
Bonnyville GHD	88	8230.4	2975	18305	2412	69	10.9	0.361	2.22	0.293	6.2	0.81
High Prairie GHD	89	7912.9	3695	24790	2619	88	11.1	0.467	3.13	0.331	6.7	0.71
Mclennan GHD	90	6184.5	2070	14275	1551	62	10.0	0.335	2.31	0.251	6.9	0.75
Westlock MHD	91	14354.7	3061	22448	2440	92	6.4	0.213	1.56	0.170	7.3	0.80
Camrose GHD	92	24401.9	4395	29323	3437	134	5.5	0.180	1.20	0.141	6.7	0.78
Metro Calgary	93	617225.9	93508	672408	73432	2552	4.1	0.151	1.09	0.119	7.2	0.79
Bashaw GHD	94	4305.2	848	6564	689	31	7.3	0.197	1.52	0.160	7.7	0.81
Border Counties GHD	95	3504.1	934	6101	755	37	10.6	0.267	1.74	0.215	6.5	0.81
Valleyview GHD	96	4699.2	2185	[illegible]	1562	48	10.2	0.465	2.79	0.332	6.0	0.71
Whitecourt GHD	97	8090.1	2071	9057	1429	54	6.7	0.256	1.12	0.177	4.4	0.69
Ft. Saskatchewan GHD	98	18527.8	3698	21559	2783	91	4.9	0.200	1.16	0.150	5.8	0.75
Ft. McMurray GHD	99	26204.6	7437	48937	5191	176	6.7	0.284	1.87	0.198	6.6	0.70
Sturgeon GHD	100	44978.0	7563	43831	5679	177	3.9	0.168	0.97	0.126	5.8	0.75
Slave Lake GHD	101	7195.3	2775	14652	1845	56	7.8	0.386	2.04	0.256	5.8	0.66
Ft. Vermilion GHD	102	9492.9	4750	22882	3135	79	8.3	0.500	2.41	0.330	4.8	0.66
Thorhild County GHD	103	7335.3	1517	10177	1238	43	[illegible]	0.207	1.39	0.169	6.7	0.82
Vilna GHD	105	3091.1	2417	14671	1661	57	18.3	0.782	4.75	0.537	6.1	0.69
Metro Edmonton	106	577617.9	96214	677886	76218	2644	4.6	0.167	1.17	0.132	7.0	0.79
Devon Area HD	149	3443.5	760	4217	666	18	5.2	0.221	1.22	0.194	5.5	0.88
Blood IR	150	3389.9	2289	10819	1542	54	16.0	0.675	3.19	0.455	4.7	0.67
TOTAL		2237257	437620	2953493	337820	11990	5.4	0.196	1.32	0.151	6.75	0.77

APPENDIX B

Computational Procedures to Derive Bed Distribution Index and Service Population Index (Bay and Nestman, 1984)

Relevance Index Method

1. Carry out a patient origin-destination study and obtain a utilization measure matrix (U_{ij}). An element of this matrix, U_{ij}, denotes the number of utilization measure units (e.g., PDAY, USWE, SEP) generated by the residents of District j at Hospital i during certain time periods.

2. The utilization measure matrix is converted to a matrix (R_{ij}), which is composed of the estimates of relevance indexes under certain homogeneity assumptions, as noted by Bay and Nestman (1980):

$$\hat{R}_{ij} = U_{ij} / \sum_i U_{ij}$$

3. The district service population size $N_{.j}$, which is the age-sex-adjusted number of residents in the District j, is multiplied by the relevance index to produce service population matrix (N_{ij}) and hospital service population vector ($N_{i.}$).

$$\hat{N}_{ij} = N_{.j}\hat{R}_{ij} \; ; \; \hat{N}_{i.} = \sum_j \hat{N}_{ij}$$

[illegible]e number of age-sex-adjusted residents served by a hospital bed, [illegible]I, may be estimated by:

$$SPI_i = \hat{N}_{i.} / B_{i.}$$

[illegible] number of beds in Hospital i, $B_{i.}$, is allocated to each [illegible]tal district in proportion to N_{ij}, and the bed allocation [illegible]x (Bij) and district bed allocation vector $B_{.j}$ are obtained

$$\hat{B}_{ij} = \hat{N}_{ij}/SPI_i \; ; \; \hat{B}_{.j} = \sum_i \hat{B}_{ij}$$

6. The number of beds per 1,000 residents in terms of age-sex-adjusted service population, BDI, may be estimated by:

$$BDI_j = 1,000 \times \hat{B}_{.j} / N_{.j}$$

APPENDIX B (Cont'd)

Commitment-Index Method:

1. As in the case of the relevance-index method, obtain a utilization matrix based on a patient origin-destination study.

2. Commitment-index matrix (C_{ij}) is estimated by the following formula under certain homogeneity assumption (Bay and Nestman, 1980):

$$\hat{C}_{ij} = U_{ij} / \sum_j U_{ij} \;.$$

3. Bed allocation matrix and vector are estimated by:

$$\hat{B}_{ij} = B_{i.} \; \hat{C}_{ij} \; ; \quad \hat{B}_{.j} = \sum_i B_{ij}$$

4. The BDIs are obtained as Item 6 of the relevance-index method.

5. The number of residents served by Hospital i from District j is assumed proportional to $\hat{B}_{ij}$, and the service population matrix (N_{ij}) and hospital service population $N_{i.}$ are obtained by:

$$\hat{N}_{ij} = (1{,}000 \times \hat{B}_{ij}) \,/\, BDI_j \; ; \quad \hat{N}_{i.} = \sum_j \hat{N}_{ij}$$

6. The SPIs are obtained as Item 4 of the relevance index method.

APPENDIX C

ALBERTA HOSPITAL SYSTEM

C.1 Acute Care Hospitals

C.2 Hospital Aggregates

C.3 General Hospital Districts

C.4 District Aggregates

APPENDIX C.1

ACUTE CARE HOSPITALS

Hospital Code	Hospital Name	Hospital Code	Hospital Name
1	Athabasca Municipal	47	Elnora General
2	Mineral Springs (Banff)	48	Empress Municipal
3	St. Joseph's (Barrhead)	49	Fairview Municipal
4	Bashaw General	50	Macleod Municipal (Fort Macleod)
5	Bassano General	52	Ft. Saskatchewan General
6	Beaverlodge Municipal	53	St. Theresa General (Fort Vermilion)
7	Bently Municipal	54	St. Joseph's (Galahad)
9	Blairmore Crowsnest Municipal	55	Glendon Municipal
10	St. Louis (Bonnyville)	56	Grande Prairie Municipal
11	Bow Island General	57	Hanna General
12	Boyle General	58	St. Anne's (Hardisty)
13	Breton General	59	Providence (High Prairie)
14	Brooks General	60	High River General
15	Alberta Children's (Calgary)	61	Hinton Municipal
16	Foothills (Calgary)	62	Hythe Municipal
17	Calgary General	63	Innisfail General
18	Salvation Army Grace (Calgary)	64	Islay Municipal
19	Holy Cross (Calgary)	65	Seton (Jasper)
20	Rockyview (Calgary)	66	Killam General
21	St. Mary's (Camrose)	67	St. Catherine's (Lac La Biche)
22	Camrose Municipal	68	Lacombe General
23	Cardston Municipal	69	Archer Memorial (Lamont)
24	Little Bow Municipal (Carmangay)	70	Leduc Municipal
25	Our Lady of the Rosary (Castor)	71	Lethbridge Municipal
26	Cereal Municipal	72	St. Michael's (Lethbridge)
27	Claresholm Municipal	74	Sacred Heart (McLennan)
28	Coaldale Community	75	Magrath Municipal
29	John Neil (Cold Lake)	76	Manning Municipal
30	Consort Municipal	77	Mannville Municipal
31	Cornation Municipal	78	Mayerthorpe General
32	Providence General (Daysland)	79	Medicine Hat General
33	Devon Civic	80	Border County General (Milk River)
34	Didsbury Municipal	81	Mary Immaculate (Mundare)
35	Drayton Valley Municipal	82	Myrnam Municipal
36	Drumheller General	83	Olds Municipal
37	Eckville Municipal	84	Big Country (Oyen)
38	W.W. Cross (Edmonton)	85	Peace River Municipal
39	Edmonton General	86	Picture Butte Municipal
41	Misericordia (Edmonton)	87	St. Vincent's (Pincher Creek)
43	Royal Alexandra (Edmonton)		
44	University (Edmonton)		
45	St. John's (Edson)		
46	Elk Point Municipal		

APPENDIX C.1 (Cont'd)

Hospital Code	Hospital Name
88	Ponoka General
89	Provost Municipal
91	Raymond Municipal
92	Red Deer General
93	Rimbey General
94	Rocky Mountain House/General
95	George McDougall (Smoky Lake)
96	Holy Cross (Spirit River)
97	Stettler Municipal
98	Stony Plain Municipal
99	St. Therese (St. Paul)
100	Taber General
101	Three Hills Municipal
102	Tofield Municipal
103	St. Mary's (Trochu)
104	Turner Valley Municipal
105	Two Hills Municipal
106	Valleyview General
107	St. Joseph's (Vegreville)
108	Vermilion Municipal
109	Viking Municipal
110	Our Lady's (Vilna)
111	Vulcan Municipal
112	Wainwright General
113	Immaculata (Westlock)
114	Wetaskiwin Municipal
115	Mary Immaculate (Willingdon)
116	Whitecourt General
117	Ft. McMurray
118	Slave Lake General
119	Sundre General
120	Sturgeon General (St. Albert)
121	Grande Cache General
122	Redwater General
123	High Level Community
125	Charles Camsell (Edmonton)
126	Colonel Belcher (Calgary)
132	Grimshaw-Berwyn Municipal
133	Fox Creek
134	Strathmore Valley General
301	Blood Indian (Cardston)
302	Medley (CFB Cold Lake)
501	Duclos (Bonnyville)

APPENDIX C.2

HOSPITAL AGGREGATES

Hospital Divisions	Hospital Codes
Healthcenter (500 Plus Beds)	16, 17, 19, 39, 41, 43, 44
Large (300-500 Beds)	92, 125
Medium (100-299 Beds)	15, 18, 20, 21, 56, 71, 72, 79, 114, 117, 120, 126
Small (1-99 Beds)	All other hospitals
Tertiary	15, 16, 17, 38, 43, 44
Secondary	18, 19, 20, 39, 41, 56, 71, 72, 79, 92, 117, 125
Primary	All other hospitals
Metropolitan	15, 16, 17, 18, 19, 20, 38, 39, 41, 43, 44, 125, 126
Regional	56, 71, 72, 79, 92, 117
Rural	All other hospitals

APPENDIX C.3

GENERAL HOSPITAL DISTRICTS

GHD Code	GHD Name	GHD Code	GHD Name
1	Mannville	46	Cereal
2	Vermilion	47	Tofield
3	Drumheller	48	Macleod
4	Islay	49	Rocky Mountain House
5	Cardston	50	Berwyn
6	Bassano	51	Sundre
8	Lloydminster	52	Rimbey
9	Hanna	53	Empress
10	Viking	54	Lacombe
11	High River	55	Flagstaff-Hughenden
12	Provost	56	Trochu
13	Athabasca	57	Glendon
14	Grande Prairie	59	Fairview
15	Red Deer	60	Spirit River
16	Innisfail	61	Boyle
17	Wainwright	63	Grande Cache
18	Elk Point	64	Lamont
19	Vulcan	65	Lethbridge
20	Stettler	66	Turner Valley
21	Peace River	67	Barrhead
22	Consort	69	Medicine Hat
23	Myrnam	70	Manning
24	Claresholm	71	Banff
25	Little Bow	72	Bow Island
26	Olds	73	Smoky Lake
27	Taber	75	Cold Lake
28	Brooks	76	Hinton
29	Magrath	77	Drayton Valley
30	Eckville	78	Lac La Biche
31	Raymond	79	Pincher Creek
32	Beaverlodge-Hythe	80	Canmore
33	Didsbury	81	Wetaskiwin
34	Vegreville	82	Picture Butte
35	Oyen	83	Leduc
36	St. Paul	84	Stony Plain
37	Ponoka	85	Breton
38	Mayerthorpe	86	Edson
39	Coronation	87	Jasper
40	Crowsnest Pass	88	Bonnyville
41	Castor	89	High Prairie
42	Two Hills	90	McLennan
43	Bentley	91	Westlock
44	Elnora	92	Camrose
45	Three Hills	93	Metro Calgary

APPENDIX C.3 (Cont'd)

GHD Code	GHD Name
94	Bashaw
95	Border Counties
96	Valleyview
97	Whitecourt
98	Fort Saskatchewan
99	Ft. McMurray
100	Sturgeon
101	Slave Lake
102	Fort Vermilion
103	Thorhild County
105	Vilna
106	Metro Edmonton
149	Devon
150	Blood IR

APPENDIX C.4

DISTRICT AGGREGATES

Geographic Division	District Codes
Metropolitan	83, 84, 93, 98, 106, 100
Suburban	99, 14, 15, 65, 69
Rural	All other districts

Ft. McMurray	99, 102
Grande Prairie	14, 32, 60, 96
Red Deer	15, 16, 20, 22, 26, 30, 37, 39, 41, 43, 44, 49, 52, 54, 56, 94
Calgary	3, 6, 9, 11, 19, 33, 35, 45, 46, 51, 66, 71, 80, 93
Lethbridge	5, 24, 25, 27, 29, 31, 40, 48, 65, 72, 79, 82, 95, 150
Medicine Hat	69, 53, 28
Edmonton	All other districts