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HOSPITAL BED UTILIZATION BY LEVELS OF CARE IN ALBERTA

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

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To my Parents,
whose love and encouragement
have made every challenge less difficult

ABSTRACT

Wherein the Province of Alberta ranks above the national average in terms of acute care beds per capita, the appropriateness and distribution of these beds for meeting the population's needs have not been analysed. This study was undertaken to develop a methodology for estimating the number (or percentage) of beds in each hospital used to provide three levels of care - primary, secondary, and tertiary - based on patients' actual care-seeking patterns.

The data base consisted of PAS abstracts and hospital Annual Returns for 1977 and 1978, and demographic data for census year 1976 for the Province of Alberta. The methodology was established on the premise that beds are not equivalent, insofar as hospitals serving a large area support different levels of care. The methodology was developed in three phases: 1) derivation of the conceptual framework for estimating bed utilization by levels of care based on a regionalization approach and patient origin-destination data; 2) establishment of two sets of hospital-specific bed utilization profiles by levels of care using two divergent models of reality (Models A and B); and 3) evaluation of the methodology by assessing the utility of the bed utilization profiles in explaining interhospital differences in operating costs.

The significant results of this exploratory study are outlined as follows:

1) There appears to be a natural regionalization process occurring with respect to the use of acute care services that conforms to the tendency of patients to minimize distance (travel time) when seeking hospital services.

2) Six distinct service regions and two major referral areas were identified.

3) The average length of stay for patients seeking care outside their district of origin exceeded the average length of stay of patients seeking care within their district of origin, for all districts except those which provided three levels of care.

4) Estimates of primary, secondary, and tertiary care utilization rates expressed as a percentage of total provincial patient days were respectively: 1) Model A - 66%, 21%, and 13%, and 2) Model B - 58%, 30%, and 12%.

5) Estimates of bed utilization by levels of care profiles for each hospital were useful in explaining interhospital cost variations, particularly the increase in diagnostic/therapeutic costs for tertiary care beds.

6) The bed utilization by levels of care profiles were ineffective in explaining interhospital nursing cost differences.

From the results obtained, it would appear that hospital bed utilization patterns, as measured by the methodology developed in this study, are linked to requirements for different levels of care, which in turn are associated with variations in hospital operating costs. Recommendations arising from these results are offered. These recommendations are aimed at validating and extending the methodology developed in this study.

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CHAPTER I

INTRODUCTION

Costs for health services are being scrutinized by the public with increasing scepticism as the philosophical trend toward regarding health care as a right and not merely a privilege grows. A pervasive aspect of the resulting demands for accountability from government agencies in the funding of health services is the request of the public for equal access to appropriate and high quality health care. Concurrently, the accelerated rates of change characteristic of modern society (Toffler, 1971) are reflected by significant developments in scientific knowledge, innovations in medical practice, and technological advances. Accordingly, the provision of health services has evolved from a simple, disease-oriented, curative system into a highly complex, multi-dimensional, health care industry. Specialization has become a dominant trend as health personnel narrow their scope of practice in order to cope with the complexities arising from these changes. The social, political, and financial costs associated with these trends necessitate careful planning for those components of the health care system most closely linked to medical-technological specialization and high costs -- namely acute care hospitals.

In responding to these demands for acountability, planning for the optimal utilization of health care resources is one of the most critical and difficult tasks currently facing decision-makers in the health care system. Planning as a rational process is dependent on the establishment of an appropriate information base. Given the relative costliness of acute care hospitals in comparison with other components of the health care system, investigation of the utilization patterns associated with acute care hospitals is essential in developing a comprehensive information base for health care planning.

1.1 Nature of the Problem

Although the Province of Alberta ranks above the national average (fourth highest) with 6.27 acute care hospital beds per capita, compared to a low of 5.55 in Quebec and high of 7.50 in Saskatchewan (Statistics Canada, 1981), the appropriateness and equitable distribution of these hospital beds for meeting the population's needs have not been comprehensively analysed (Dartnell, Pincock, Moore, Flynn, & Ding, 1977; Hospital Utilization Committee, 1980). It would appear that three confounding dimensions of hospital utilization limit the completion of such an analysis. The first dimension relates to the impact of referral patterns on hospital utilization. The geographic distribution of the population has traditionally formed the basis for predicting utilization behaviours and allocating hospital beds. However, preliminary investigations indicate the existence of patient referral patterns, resulting in actual utilization patterns for hospital services that vary substantially from those expected using the more traditional (per capita) demographic approaches (Dartnell et al., 1977; Paine, 1975). Furthermore, establishment of an equitable basis for the distribution of hospital beds is complicated by the existence of significant variations in the operating expenditures per patient day across provincial acute care hospitals. The magnitude of these variations, which range from $71.84 to $501.33 per patient day in 1978-1979 (Alberta Hospitals and Medical Care, Undated, pp. 74-76), indicates that hospitals may conceivably provide varying levels of services; thus, the equitable distribution of health care resources might more accurately be assessed in terms of the number (or proportion) of beds in provincial hospitals which are used to treat patients requiring different levels of care. Although it is generally acknowledged that the nature of acute care services required by a patient depends on the complexity of his/her illness, lack of valid measures of need for these services further compromises the determination of an equitable distribution of resources. These three interactive dimensions are perceived to constrain a comprehensive assessment of the stated problem.

1.2 Purpose, Objectives, and Approach

The main purpose of this study is to conduct an exploratory analysis of utilization patterns for Alberta acute care hospitals in order to develop a methodology for estimating hospital bed utilization by levels of care, which reflects the actual care-seeking behaviours of Albertans. To accomplish this, the following research objectives were established:

1) to derive a conceptual framework for estimating acute care bed utilization by levels of care based on an analysis of geographic variations in patient utilization patterns;
2) to develop a methodology for estimating the numbers (or percentage) of beds in each hospital used to provide primary, secondary, and tertiary care to Albertans, using a series of patient origin-destination analyses; and
3) to evaluate the utility of this methodology by assessing the relationship between estimates of bed utilization by levels of care for each hospital and operating costs.

The establishment of planning alternatives which may be used to reinforce Government policy decisions is frequently restricted by lack of suitable information. In undertaking this study, the investigator has endeavoured to use data which are readily available to provincial government personnel and, in the process, to assess the usefulness of these data in planning for the optimal distribution of acute care hospital beds in Alberta.

It appears from the researcher's investigations that the development and application of a common methodology to all hospitals in a large study area, in order to derive hospital-specific estimates of bed utilization by levels of care, represents a new approach to studying hospital bed utilization. In deriving the methodology, it was necessary to evolve estimates of unknown population parameters based on assumptions (models) of reality as perceived by the researcher. As a means of testing the research approach, the methodology developed in this study was applied, incorporating two different models.

1.3 Significance of the Study

Acknowledgement of the finite nature of resources available for ensuring the public's welfare places a premium on the rational distribution of these resources, particularly in regard to proportionately high cost components such as hospitals. Within the health care system, the initial policy decision to allocate funds for the construction of hospital beds embodies significant long-term financial implications. Based on recent per patient day operating costs and occupancy rates (Alberta Hospitals and Medical Care, Undated, pp. 74-76), estimates of total operating expenditures per hospital bed over a 30 year life span range from $620,000 to $4,400,000 in constant 1978 dollars. If the current trend towards medical specialization and the implementation of sophisticated, costly diagnostic-treatment technologies continues, escalation of costs will persist, particularly for those acute care hospital beds which are designated for treating more seriously ill patients.

With the removal of most economic obstacles to obtaining health care services, the traditional economic supply and demand theories are inadequate for regulating the number and distribution of hospital beds. At the same time, different segments of the population espouse justifiable, but frequently divergent perspectives on the optimal allocation of health resources. In fulfilling its mandate, the Government's policy decisions regarding the allocation of health resources, such as hospital beds, should be based on rational information. In view of the various contextual variables involved, however, health care planners and policy initiators face a formidable task in determining acute care bed allocations which are economically, socially, medically, and politically viable.

In view of these complexities, the research undertaken in this study has multi-dimensional value. Specifically, the use of patient origin-destination data takes into account the variety of extraneous variables (e.g., patient preferences, physician referral practices, climatic factors) which influence patients' actual utilization patterns. Estimates of the number of beds used to provide primary, secondary, and tertiary levels of care may be employed, in conjunction with small area variations in utilization rates, to detect possible imbalances in the provision of different levels of inpatient hospital services to specific populations. Given the premise that construction and operating costs involved in funding a primary level bed should be less than the associated costs of a tertiary level bed, a planning methodology which incorporates this degree of differentiation in calculating requirements for acute care beds has increased potential for cost-effective and efficient resource allocation. Determination of the relationship between referral patterns, geographic regions, and the designation of three levels of acute care beds may be of relevance in assessing the feasibility of regionalizing health care services. The findings of this study may be used to avoid duplication of expensive services in that the natural propensity of the population to utilize specific services may be assessed and regional boundaries determined or adjusted to reflect these patterns.

In recognition of the complexities of the health system, the investigator has undertaken this study in an effort to investigate new approaches to the problem and, thereby, to contribute to the development of a more rational basis for determining health resource allocation.

1.4 Scope, Assumptions, and Limitations

Scope. This study involves an exploratory, cross-sectional analysis of acute care hospital bed utilization patterns in Alberta, and the use of these data to develop a methodology for estimating the number (or percentage) of beds in the 121 provincial hospitals used to provide primary, secondary, and tertiary levels of care. The study is restricted to Alberta residents hospitalized in acute care hospitals in the province. Due to the lack of appropriate data, evaluation of two aspects of utilization behaviour were deemed beyond the scope of this study: 1) identification of the factors which influence care-seeking patterns when patients are faced with alternative sources of care, and

2) determination of whether or not there are sufficient hospital beds in Alberta to satisfy the health needs of the population.

Assumptions. Implementation of this study was contingent upon the validity of the following research assumptions.

1) By restricting the study to Albertans hospitalized in provincial acute care facilities, utilization data were analysed as if the province has a closed hospital system. Thus, it was assumed that non-residents accessing provincial hospitals and Albertans seeking care outside the province would have a negligible effect on the research results. This assumption was necessary insofar as utilization data for these two sub-populations were not readily available and/or in a form that could be analysed within the framework developed for this study.

2) Lack of generally accepted criteria for determining the appropriate amount of care required by patients limits attempts to ascertain under or over-utilization. To compensate for this absence of valid standards, it was assumed that current utilization rates approximate the true need for various levels of inpatient acute care service in the province. In other words, the determination of adequate levels of utilization is in "relative" rather than "absolute" terms.

3) A normative view of morbidity was adopted, based on the assumption that the basic needs of the study population for different levels of inpatient hospital care are more or less similar (although actual utilization rates for small geographically differentiated subpopulations may vary to some degree).

4) It is an accepted tenet that variations exist in the level of complexity and intensity of services available at different hospitals and required by patients. Numerous factors must be considered in achieving an optimal match between the needs of patients and the services provided; measurement problems have limited the quantification of the components of this interaction. The terms "primary", "secondary", and "tertiary" are commonly cited as a relative means of distinguishing among levels of hospital care. For the purposes of this study, it was assumed that the ministrations provided by hospitals serving a large area could be differentiated into three levels of care. Furthermore, the assumption was made that provision of different levels of care is successively inclusive: lower level services are available in hospitals providing higher level care. This assumption appears reasonable given that: 1) most seriously ill patients required lower level services as well as specialized care, and 2) more complex levels of care are characterized by increasing degrees of personnel expertise and technological innovations.

5) To establish a geographic basis for assessing the provision of acute care services in the study area using patient origin-destination data, it was assumed that the most appropriate unit of analysis would be the pre-established 'hospital districts': these districts divide the province into 103 mutually exclusive and exhaustive geographic areas. A further assumption was made that these hospital districts could be aggregated to form larger, more comprehensive regions which conform to patient referral patterns.

6) Congruent with the regionalization or ecology approach to analysing patients' care-seeking behaviours, it was assumed that hospitals and hospital districts could be classified, according to differences in the levels of care provided or available for patients. These classifications formed the basis for measuring patient utilization rates by levels of care.

7) Two related assumptions regarding the concept of distance minimization were applied. First it was assumed that patients would access the hospital(s) located within their district of origin (i.e. the closest facility) if the appropriate level of care was available. If the required level of care was unavailable, it was assumed that patients would then travel (be referred) to the nearest hospital in another hospital district providing the necessary level of care. Utilization research has shown that distance minimization is a predominant factor influencing patients care-seeking patterns, particularly in rural areas. Given the geographic characteristics of Alberta, these distance minimization assumptions appear logical.

8) Notwithstanding the effects of economies of scale in the provision of hospital care, it was assumed that the increased concentrations of specialized personnel and sophisticated technologies required to provide higher levels of care, give rise to inter-hospital variations in operating costs. At least part of these costs are related to the distribution of beds among the three levels of care, namely, primary, secondary, and tertiary.

Limitations

The limitations affecting this study are associated primarily with limitation in the data and analytic techniques applied.

1) The data used in this study were obtained from government sources which, in turn, were derived mainly from the compilation of many regular reports submitted by the various hospitals. Compatability of the data is limited by the consistency among hospital personnel in interpreting and adhering to established criteria for data collection. Verification of the reliability and validity of these data was impractical given the quantity and confidential, technical nature of the data.

2) A limitation in assessing the utilization data relates to the unit of analysis employed during collection of these data. Utilization data are compiled using the separation episode rather than the patient as the unit of analysis. Every patient admission to a hospital, whether it involves re-admission for treatment of the same disease episode or a transfer from another hospital is recorded as an independent event (i.e., new patient separation). As a result, the utilization data may tend to over-represent the number of cases treated in hospitals which transfer many cases to referral hospitals. To partially compensate for this limitation, analyses involving utilization data were completed using patient days, as well as separations.

3) This study was limited to a cross-sectional analysis of acute care utilization patterns based on the most current data available (1977 and 1978). The investigator acknowledges that a longitudinal study, which incorporates utilization data collected over

an extended time period, would provide a more comprehensive assessment. However, complicating circumstances, including changes in data definitions and the prodigious amount of data involved, would have constituted an unwieldy data base, inappropriate for purposes of this study.

4) Analysis of hospital bed utilization patterns, in conjunction with the related demographic data, was limited by lack of census statistics for the corresponding years. Insofar as detailed, area-wide demographic data are available for census years only (e.g., 1971 & 1976), a two year differential exists between the utilization data analysed in the study (1977 and 1978) and the most current census data available (1976). This time lag may have contributed to minor under or over-estimates when adjustments were made for age-sex differences in the sub-populations.

5) Patient origin-destination analyses undertaken in this study were limited by the use of hospital districts as the basic geographic unit of analysis. Significant variations exist in the circumferance of these hospital districts, the demographic characteristics of the related populations, the transporation systems available to district residents, and the locational configuration of associated acute care facilities. Thus, the distances travelled by patients when seeking care from hospitals located within their district of origin or from the next "closest" hospital providing higher levels of care may not always be comparable. Although it is recognized that patient origin-destination data, based on point specific locations, would provide increased accuracy, the collection of such

data and the complex analyses involved were deemed to be beyond the scope of this study.

1.5 Definitions of Terms and Concepts

The utility of any research is predicated on clarification of integral terms and concepts. Within the context of this study the following definitions were used.

1) ACUTE CARE HOSPITAL - a facility which provides primarily for the diagnosis and short-term treatment of patients with a wide variety of diseases or injuries, with services unrestricted to a specific age group or sex.

2) ACUTE CARE/SERVICES - refers to those diagnostic/treatment activities involving patients after they have been admitted to a hospital (i.e., occupy an acute care hospital bed). Services/care obtained by patients on an outpatient basis are not included.

3) PATIENT ORIGIN - connotes the hospital district where a patient normally maintains his/her residence or legal address.

4) DESTINATION - designates the acute care hospital from which a patient is discharged following an episode of illness necessitating inpatient services/care.

5) LEVELS OF CARE - represent the varying intensity or complexity of inpatient care/services provided within an acute care facility. The terms primary, secondary, and tertiary are used to distinguish, in relative terms, the increasing degree of complexity and intensity in the levels of care a hospital is equipped and staffed to provide. Primary level care includes the provision of a large number of basic services; tertiary level care represents the least common and highly specialized services provided at the opposite

end of the severity-complexity continuum, whereas secondary level care denotes those services required by patients who are moderately ill.

6) PATIENT SEPARATION - the official departure of a patient (alive or dead) from a hospital. Discharge of a newborn is deemed to occur at the time of official release from the hospital.

7) PATIENT DAY - 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.

8) PATIENT DAYS - total number of days spent by hospital inpatients during a specified time period.

9) AVERAGE LENGTH OF STAY - the average number of days spent in the hospital by inpatients who were separated from the hospital (dead or alive) during a specified period. This is calculated by dividing the total number of patient days generated by separations for a specified time period.

10) BED UTILIZATION BY LEVELS OF CARE PROFILES - an estimation of the number (or percentage) of beds in each hospital used to provide Level 1 (primary), Level II (secondary), and Level III (tertiary) care to patients based on the methodology developed in this study.

11) CLASSIFICATION - the homogenous arrangement of hospitals and hospital districts by levels of care provided or available, respectively.

1.6 Thesis Format

The thesis is presented in six chapters and four appendices. In Chapter I the research objectives, significance of the study, scope, assumptions, limitations, and essential definitions are noted. Chapter II is comprised of a review of literature relevant to the research objectives. Development of the conceptual framework used in this thesis is delineated in Chapter III. In Chapter IV, the methodology for estimating hospital beds by levels of care is derived, and the resulting application of this methodology is presented. An evaluation of the methodology provides the focus for Chapter V. In Chapter VI, the final chapter, a summary of the research findings, major conclusions, and implications for further research are outlined. Clarification or elaboration of specific aspects of this study are presented in Appendices A-D.

CHAPTER II

A SELECTIVE REVIEW OF THE LITERATURE

The following selective review of the literature is designed to provide an overview of developments and research findings in health care and related fields of study which are of relevance in achieving the objectives of this study. The four main areas included in this literature review are: 1) the theoretical relationships among concepts of need, demand, and utilization as related to the consumption and allocation of the health care resources; 2) uses of classification methodologies in health care with a major emphasis on the issues associated with measuring hospital output and the results obtained when measures of outputs are used to group hospitals; 3) applications of patient origin-destination methodologies in assessing hospital utilization patterns and resource allocation; and 4) previous studies conducted on the Alberta health care system which are pertinent to this thesis.

2.1 Need, Demand, and Utilization as Determinants of Health Care Resource Allocation

Congruent with the tenet that a system exists for the purpose of accomplishing a goal(s) (Churchman, 1968), a primary goal of any health care system is to ensure the efficient allocation of resources in meeting the health needs of the population. Inevitably, in attempting to achieve this goal, discrepancies appear between the perceived need for health care and the quantity and distribution of resources to satisfy this need. The resulting ambiguity, uncertainty, and controversy can be linked to three aspects of need as used in relation to the system: 1) lack of a commonly accepted definition and/or measure of health care needs; 2) existence of multiple and divergent choices on the relative balance of manpower and facilities which are appropriate in meeting health needs; and 3) the responsiveness of the population's need to changes in numerous, complex variables influencing utilization (White, Anderson, Bice, Kalimo & Schach, 1976; p. 207).

2.1.1 Definitions of Need, Demand, and Utilization within the Health Care System

Determination of the optimal level of resources necessitates the existence of acceptable criteria for assessing need and for evaluating the effectiveness of the measures taken in alleviating that need. Traditionally, neoclassic economic theorists have analysed health care needs as an aggregate concept by using the level of demand, determined by the pricing mechanism of the competetive market place (Boulding, 1966, p. 202; Maynard, 1979, p. 121.) Demand equilibrium becomes the proxy estimate for need. Three significant factors influencing the utilization (need) of health care services include: 1) the stochastic nature of illness; 2) the lack of comprehensive information which deters consumers from making rational choices when selecting health care services; and 3) the presence of externalities which result in related costs or benefits in excess of the price charged to the consumer. These factors result in serious challenges to the appropriateness of the market concept of demand as a basis for defining health needs and for allocating health care resources (Arrow, 1963; Culyer, 1971; Evans, 1974; Maynard, 1979).

Boulding (1966, p. 214), Cooper (1974, p. 91), Field (1973, p. 766) and MacStravic (1978, p.8) added further substance to this perspective by elucidating that insofar as health tends to be socially defined, the individual's need for health care is a relative concept, lacking objective reality and subject to the evolving values of society. Meanwhile, physicians who have been designated by society as the "social gate keepers" of health care have evolved as the experts in defining health needs. Their decisions have a significant impact in determining the quantity and distribution of health care services (Arrow, 1963, pp. 44-47; Cooper, 1974, p. 91; Griffith, 1972, p. 6; MacStravic, 1978, p. vii).

Other researchers have supported the perspective that need should be defined as the amount of health services required to maintain a specific population at a stipulated level of 'well-being'; well-being tends to be measured against a subjective definition of the optimal level of health, based on current medical knowledge and usually established by a group of experts (physicians) (Allen & Karolyi, 1976, pp. 17-18; Cooper, 1974, pp. 91-92; Feldstein, 1979, pp. 74-78; Griffith, 1972, pp. 20-21; Shonick, 1978, p. 8; Warner & Halloway, 1978, pp. 239-240). Jeffers, Bognanno, and Barlett (1971) identified the weaknesses which limit this approach to defining health needs:

> An accurate specification of a population's 'needs' for medical services requires perfect knowledge of its members' health, the existence of a well-defined standard of what constitutes 'good health', and perfect knowledge of what modern medicine can do to improve ill (or below standard) health. It must be acknowledged that existing diagnostic procedures are not capable of providing perfect knowledge of the state of any population's, or even an individual's health. It also must be acknowleged that a clear-cut consensus as to what constitutes 'good health' does not exist among professionals. (p. 47)

In recognition of these limitations, many of the preceding authors defined demand apart from the concept of need and, in the process, delineated two different components of demand which for purposes of this study have been labelled 'expressed demand' and 'unexpressed demand'. Expressed demand refers to the level of health care used, arising from the initiation of either the individual patient (including his/her guardian) or the physician acting as the patient's advocate in the process of care (diagnosis and treatment). As such, expressed demand was deemed to correspond to the level of <u>actual</u> usage patterns for health care (Griffith, 1972, p.21). Consequently, this component of demand in health care was identified as the "utilization" level for health care services (Scanlon, 1980 pp. 832823; Stuart & Stockton, 1973). The second component, unexpressed demand, was defined as the level of services in excess of expressed demand (utilization) that consumers would use if unrestricted by financial or supply constraints (Cooper, 1974, pp. 91-92; Griffith, 1972, pp. 20-21).

As an alternative to the aggregate approach, Donabedian (1973) proposed a patient-centred conceptual model for assessing health resource allocations. The dual nature of health care interactions, involving the patient as well as the physician, was the primary focus. In developing this model, Donabedian (1973) defined need as:

> the states of health of illness as viewed by the client, or the physician, or both, as likely to make demands on the medical care system. Need is defined, therefore, in terms of the phenomena that require medical care services. (p. 64)

From the preceding literature review, it is apparent that the definition employed in determining the existing level of need in the population, and the approach used to measure health needs have a direct impact on the allocation of health care resources. Due to the failure to achieve consensus on the criteria for assessing need (Boulding, 1966, p. 202) and the supposition that infinite resources would not eliminate all health care needs (Cooper, 1974; Feldstein, 1967), health care planning according to need appears unattainable and potentially very costly. Thus many policy makers advocate reliance on actual utilization behaviours as the basis for allocating health resources (Allen & Karolyi, 1976, p. 17; Feldstein, 1979, pp. 74-102; Griffith, 1972, p. 21). However, general disagreement among experts as to what mix of services should be employed in order to alleviate the identified state of need also influences the allocation of resources. This aspect is considered within the subsequent section.

2.1.2 Determination of the Appropriate Allocation of Resources

In recent years, the most salient characteristic of health care systems in industrialized countries is the trend towards specialization and increasing complexity in the delivery of health services. A significant aspect of this trend has been the exponential increase in diagnostic/treatment protocols available and the skilled personnel employed in the provision of health services (Field, 1973, pp. 71-72, 75-76; Mechanic, 1977, pp. 62 & 69). Despite the extra resources used to provide these more complex medical services, it has been noted that related increases in productivity (as measured by improvements in the general health status of the population) have not occurred (Fuchs, 1979, p. 155; Mechanic, 1977, p. 62). Assessment of an optimal mix of resources has been compromised by difficulties in evaluating the large numbers of new diagnostic/treatment services and by the apparent high value that the public places on the availability of these costly, technologically complex health services (Inglehart, 1977, pp. 25-26; Field, 1973, p. 775).

Failure to achieve positive changes in the general health status of a population with the use of more, costly, technologically sophisticated diagnostic-treatment services has implications in selecting the optimal mix of health care services. Bennett (1977, p. 129) and Field (1973, pp. 775 & 779) noted that recent changes in the health care system have usually been characterized by specialization and increasing complexity which were associated with "add-on" technologies instead of "substitute" technologies. The use of substitute technologies was perceived as providing an improved, more efficient and more productive means of accomplishing an existing task; whereas, the deployment of add-on technologies was seen as enabling the completion of tasks that were previously beyond the capabilities of medical practice. Bennett (1977) maintained that add-on technologies have a neutral or negative impact on overall productivity because: 1) additional costs are generated in providing these new services without improving the basic health status of the population, and 2) social cost may soar as a by-product of these technological add-ons (i.e., long term chronic care of a paraplegic "saved" by advances in technology).

A similar perspective was enunciated by Mechanic (1977, p. 62) in identifying the limitations of recent medical-technological developments which he labelled "halfway technologies". The majority of these expensive, sophisticated medical technologies tend to be associated with acute care hospital settings (Mechanic, 1977; Phillips, 1973; Russell, 1976). Russell (1976, p. 570) found that consideration of the high cost component services provided in a hospital, as opposed to analysing the hospital as a single service entity, was imperative in assessing the optimal allocation of resources for different service needs.

Industrialized countries have continued to expend the largest portion of health resources on sophisticated, technology oriented, hospital based health services (Abel-Smith, 1976; Blanpain, 1975, pp. 84-89; Groot, 1975, pp. 50). Statistics illustrate that institutionally based health care services continue to receive the largest proportion of the health budget in Canada (Statistics Canada, 1962 & 1980). It is suggested that government funding of research on life-prolonging, and life-saving technologies (Inglehard, 1977, p. 26) and the inability of countries, which have health care systems financed through third-party insurance, to institute a comprehensive resource rationing mechanism (Mechanic 1977, p. 53) have fostered unrealistic public expectations regarding modern medicine. Consequently, demands for care have escalated, with significant implications for planning of resource intensive services such as those provided in hospitals.

Medical care "has become one of the largest industries in modern society" (Fuchs, 1979, p. 155). Techniques are needed to control the rapid proliferation in the number of service options available, pending evaluation of their cost efficiency and ease of accessibility for needy populations (Greenwald, Woodward & Berg, 1979). Mechanic (1977, pp. 69-72) advocated the formulation of a planned system of primary, secondary and tertiary levels of services as a means of ensuring more efficient allocation of health resources. Primary level services would provide the main entry point to the system, with the potential for coordination between the more expensive secondary or tertiary level services, and the primary level controlled by regulation through the planning process (Mechanic, 1977, pp. 71-77). This approach to rationing health resources assumes that alternative mixes of resources may be used in satisfying similar care requirements.

Given the complex supply and demand factors affecting the health care system, it is suggested that it may be unrealistic to expect that resources could be allocated on a strictly rational basis. Instead, "a more informal and flexible planning process is necessary, which inevitably leads to inequalities, at least where the allocation of very high cost, advanced technological procedures are concerned" (Office of Health Economies, 1979, p. 283).

In summary, various alternatives exist in determining the appropriate mix of resource allocations in health care. The proliferation of expensive medical technologies and the public pressure to make these services available without regard to cost efficiency at an aggregate level servcs to complicate the realization of optimal resource allocation, particularly for those services provided in acute care hospitals.

2.1.3 Variables Influencing Utilization

In addition to the difficulties in defining health needs and uncertainty regarding the appropriate mix of resources to be required, planning for the optimal distribution of resources is further complicated by the complex factors affecting health care utilization. The literature is replete with studies which have endeavoured to identify and quantify the impact of these variables, especially in regard to hospital utilization; nonetheless, a selective review of this research illustrates that the nature of the relationship between these variables and utilization behaviour remains unclear. Although many different models exist for analysing these relationships, three dimensions are commonly cited as influencing health care utilization: 1) demographic characteristics; 2) organization of the health care system; and, 3) societal trends (Andersen & Newman, 1973; Anderson, 1976 & 1973; Feldstein & German, 1975; Kennedy, 1980; Rosenthal, 1965; Rothberg, Pinto & Gertman, 1980; Veeder, 1975).

Extensive research has been conducted to evaluate the importance of demographic variables on hospital utilization. With regard to ethnic composition, various authors noted an inverse relationship between the percentage of non-whites in the population and hospital utilization (patient days or admissions) (Andersen & Newman, 1973; Feldstein & German, 1975; Cordle & Tyroler, 1974). Conversely, Ferguson (1976) found a positive relationship between the proportion of non-whites in the population and average length of stay (ALOS). Similarly, while various reseachers identified that older patients required increased hospital services (Andersen & Hull, 1969; Anderson 1973; McCarthy & Finkel, 1980), other researchers demonstrated that controlling for age produced insignificant effects on overall ALOS (Gornick, 1975; Rothberg et al., 1980). Investigations of the rural versus urban demographic dimensions have produced conflicting results. Anderson (1973), Andersen and Hull (1969), Harris (1975a), and Ro (1969) proposed that use of hospital services was positively related to the degree of urbanization; whereas the results of other research studies showed an inverse relationship (Feldstein & German, 1975; Roth et al., 1955). Analysis of demographic impacts of utilization related to socio-economic status have also yielded contradictory results (Bice & Rabin, 1973; Metcalfe, 1977).

A number of studies focused on the organizational dimensions of the health care system and the associated effects on utilization. Substantial evidence exists to support the hypothesis (widely referred to as "Roemer's Law") that an increase in availability of services (e.g., hospital beds) leads to higher rates of utilization (Anderson, 1973; Harris, 1975b; Roemer, 1961a; Rogatz, 1974; Shain & Roemer, 1959). However, other researchers postulated that the number and distribution of physicians have a significant impact on the relationship between bed supply and utilization, that conceivably distorts the manifest effects (Evans, 1974; Ro, 1969; Roemer, 1961b; Rogatz, 1974; Rothberg et al., 1980). Indeed, the results of other studies indicated that both the number and type of physicians (general practitioners vs. specialists) have variable, mediating influences on utilization behaviour which may diminish the influence of bed supply (Gaag, Rutten & Praag, 1975; McCarthy & Finkel, 1980; Rutten & Gaag, 1977). Other studies focused on the locational efficiency of hospital-related services and the influence this had on utilization (Abernathy & Hershey, 1972; ReVelle, Bigman, Schilling, Cohon & Church, 1977; Schneider, 1967). From a different perspective, the teaching status, use of specialty consultants, and reputation of the hospital (Eastaugh, 1979; Ro, 1969) were identified as factors affecting utilization. Other researchers concluded that the type of illness had negligible effects on average length of stay (ALOS) and/or utilization patterns associated with different regions and hospitals (Andersen & Hull, 1969; Harris, 1975b). Depending on the research perspective, the effect of organizational variables on utilization appears highly variable.

Societal trends, related to changing values and beliefs, affect the structure of the health care system and associated utilization patterns (Andersen & Newman, 1973; Fuchs, 1979; Field, 1973). Researchers have identified that technological changes (Mechanic, 1977; Russel, 1976) and lifestyle variables (Lalonde, 1974; Mason, Bedwell, Swagg, & Runyan, 1980) are apparently related to utilization patterns. However the effects of these determinants are somewhat distorted by the increasing bureaucratization of the health care system (Field, 1973; Fuchs, 1979) and the "technological imperative" (the proclivity of physicians to employ new technologies simply because they exist) (Fuchs, 1968). Thus the abstract, interactive nature and gradual evolution of these trends inhibit endeavours to clarify and quantify their impact on the manifest demands of the population for health care.

Based on the preceding selective review of the more commonly researched variables, it is apparent that the nature of these relations is imprecise and often contradictory, depending on the perspective assumed. Measurement of their impact on utilization is therefore very difficult.

2.1.4 Summary

An overview of the theoretical relationships among need, demand, and utilization was provided as a basis for understanding the complexities involved in establishing a rational method for assessing need and for ensuring an equitable distribution of health resources. The major points related to the preceding literature review are as follows:

1) Measurement of need for health services is constrained by the abstract, subjective nature of the concept. The amount of health

services demanded (utilization) has generally been accepted as an appropriate, proxy measure of need for health services.

2) The determination of optimal resource allocation is complicated by the proliferation of medical technologies, which have increased the number of treatment alternatives. This situation is particularly noteworthy in determining resource allocation for technology intensive facilities such as acute care hospitals.

3) Health utilization patterns are a result of the combined effects of numerous, complex variables, related to demographics, organizational characteristics, and social trends. Researchers have been relatively unsuccessful in clarifying the relationships between these variables and utilization patterns.

2.2 Classification and the Allocation of Health Resources

Vast amounts of data are required to provide a comprehensive assessment of the complex nature of the health care system as manifested in patient utilization behaviour. Assimilation of these data has often been facilitated by the use of data reduction techniques. Classification is a data reduction technique which is widely used for this purpose in various fields of study, including the health care system. In the dictionary sense, classification is defined as "arrangement according to some systematic divisions into classes or groups" (Webster's, 1979, p. 263). Within the context of the health care system, the Report of the Working Party on Patient Classification (1973, p. 7) stated that the precise meaning of classification is "conceptually different" depending on the circumstances and purpose surrounding its use. The primary purposes of classification are: 1) to facilitate the summarization and labelling of data for economy of memory and clarification of communication; 2) to describe and simplify the structural relationships between constituent elements thus enabling the grouping of homogeneous elements according to general, identifiable criteria; 3) to represent the data such that areas for further research are indicated; and 4) to simplify the retrieval of small amounts of information from a large system (Cormack, 1971, p. 322; Sokal, 1974, p. 1116).

An understanding of the three main applications of classification techniques in the health care system is germane to the objectives of this study. A brief overview of two applications, disease classification and patient classification is provided primarily in order to clarify the concepts and terms. A more indepth overview of literature pertaining to the third application, hospital classification, is presented because of its relevance to this study.

2.2.1 Disease Classification

Traditionally, the classification systems developed for use in medicine have been etiologically oriented (Bay, Stinson, & Leatt, 1982, p. 5). This orientation followed from the need to compile vital statistics and to evaluate progress in disease control. In 1883, several European countries compiled the first disease classification system by cause of death (World Health Organization, 1977, pp. VIII-XIII). This system evolved slowly until the World Health Organization published the first comprehensive morbidity and mortality classification manual in 1948 (6th Revision of the International List of Diseases and Causes of Death). Based on this manual and subsequent revisions (known as the International Classification of Diseases (ICD)), two major disease classification systems were developed to meet the demands of the North

American health systems. First in 1959 the United States Public Health Department developed a modified version of the I.C.D. Revisions, entitled ICDA (International Classification of Diseases, Adapted for Indexing Hospital Records by Disease and Operations). Then, in 1968 the United States National Committee on Vital and Health Statistics released ICDA-8 (International Classification of Diseases, Adapted for Use in the United States) (Commission on Professional & Hospital Activities, 1969, pp. v-vi).

Since 1954 the Commission on Professional and Hospital Activities, through an affiliated program known as the Professional Activities Study (PAS), has worked extensively with a large group of North American hospitals in refining and formulating classification systems for collecting and analysing statistics primarily for evaluation of hospital operations (Commission on Profession & Hospital Activities, 1969, p. IV). The PAS sponsored modification of the ICDA-8, known as the Hospital Adaptation of ICDA-8 (H-ICDA) provided a disease classification system which was predominantly clinically oriented and conformed to complex North American acute care usage requirements (Commission on Professional & Hospital Activities, 1968, pp. IX-XV). Provincial hospitals in Alberta use the PAS disease classification system for tabulating morbidity and mortality data. In addition, The Canadian Diagnostic Codes (CDC), an abridged version of the three digit level ICDA-8 system developed by Statistics Canada (1975) for Canadian use, can also be derived from the PAS data collected for Alberta.

Disease classification systems provide a relatively efficient, simplified, objective approach to collecting a large amount of precise, health-related utilization data. Nonetheless, several weaknesses in the disease classification system have been identified, including: 1) etiological inadequacies for specific diseases; 2) difficulties associated with comorbidity; and 3) wide variations in the intensity and amount of therapeutic requirements within a disease category (Bay, Stinson & Leatt, 1982, p. 5). In an effort to overcome some of these deficiencies, especially in determining wide variations in individual care requirements, patient-oriented classification systems have evolved.

2.2.2 Patient Classification

Alberta health care literature is replete with references to patient classification systems. The intent in this literature review is to provide an overview of patient classification concept which is relevant to this study. The Report of the Federal Working Party on Patient Classification (1973) presented an inter-related three "universe" conceptual framework for patient classification. The framework provided a comprehensive basis for classifying an individual's needs for care at three different phases in the operation of the health care system. The first classification system, which corresponds to the most general universe, involved the categorization of the total population by the broadest categories of need, labelled "Categories of Health and Social Need". Included in this classification is the determination of resource allocations according to such broad categories as preventative, public health, information, guidance counselling, ambulatory, and institutional services (1973, pp. 15-21).

The second universe assumes that the individual manifests a specific need for health and social services. It was proposed that "Types of Care Classification" was required at this phase, in order to match the needs of the patient with the most appropriate program component (or health care setting) available within the current health care system (1973, pp. 24-41). Using this approach, the entire spectrum of care settings was linked to the corresponding care needs of patients and categorized into five distinctly different "Types of Care". The types range from Type I, associated with an ambulant patient who needs minimal care, through Types II-IV, which were designated categories for patients requiring different types of chronic care services, to Type V which was designated for patients requiring the services of acute care hospitals.

The third classification approach, "Levels of Care Classification" (1973, pp. 55-63), applied to intra-hospital classification systems. Levels of Care Classifications were conceptually defined as the categorization of patients according to their varying needs for nursing care within a specific care setting (e.g., all patients in Type V institutions). The measure of nursing care required was deemed to provide a surrogate measure of the volume and intensity of care needed (health resources) by patients in each level of care. It was acknowledged that this measure of need should be expanded to include all dimensions of care, not just nursing care, so that valid assessments of patients' needs and resource requirements could be made (Report of the Federal Party on Patient Classification, 1973, pp. 55-57).

Empirical investigations of the utility of these three different approaches to patient classification have been limited generally to Types of Care and Levels of Care Classification systems. It would appear that Types of Care Classification systems should have application in this study, at the theoretical level, by providing the conceptual basis for identifying that patients using acute care hospital services can be viewed as a unique subpopulation (Type V) within the larger context of the health care system. Similarly, it would appear that the Levels of Care approach to classification and determination of resource allocation is relevant at the conceptual level. The conceptual perspective that patients' levels of care vary and that these levels of care can be differentiated by measuring the services required within one care setting supports the contention proposed in this study: that on a conceptual basis the beds of an acute care facility could be classified as a proxy measure of a hospital's resources allocated to patients within different care levels.

Use of patient classification methodologies as a means of determining resource allocation on a broad scale (across institutions) is limited by the reliance on need as a basis for assessment and by the lack of objective criteria for deriving levels of care classifications, because it has been developed primarily for intra-hospital use. It is unfortunate that levels of care classification has adopted relative terminologies to label each level such as average or above average, strongly suggesting that the results obtained are dependent on the institution involved. Even if comprehensive criteria were available for describing patients' needs, in the absence of a valid measure of quality of care, quantification of care requirements for individual patients would continue to be affected by the value judgements and skills of the observer and the environmental influences unique to each care setting (Ciovannetti, 1978, pp. 84-89). Thus, the validity of statistical comparisons based on a level of care patient classification, for different hospitals in a large study area, is suspect.

Further, this approach would require substantial resources because individual assessment and classification of all or of a representative sample of acute care patients would be necessary. In an endeavour to circumvent some of these inherent weaknesses in the use of information obtainable from a patient classification approach for planning and resource allocation, particularly in the acute care component, researchers have tended to investigate the supply aspects of the system (i.e., services provided). This has resulted in the use of classification methodologies for comparing efficiencies in the use of health resources across hospitals.

2.2.3 Hospital Classification

In the broadest sense, the main function of an acute care hospital is to provide health care to a population in need; more specifically, this may be intepreted as supplying diagnostic-treatment services for the clinical management of patients. Since acute care hospitals have the highest rate of resource consumption, in comparison with other components of the health care system, research has focused on the efficiencies of hospitals in supplying these services to patients. A by-product of these investigations has been the evolution of hospital classification methodologies as a means of comparing the use of resources by homogenous facilities.

Defining the Supply Function for Acute Care Hospitals. Supply, as used in economics, denotes the amount of output (product) a firm wishes to sell (Lipsey, Sparks & Steiner, 1973, p. 70). Within the unique, non-profit health care market, this term more appropriately denotes some gross measure of need or demand (e.g., bed/population ratios) or some other proxy measure of output (e.g., amount of nursing care required) (Donabedian, 1973, p. 212). In both instances, evaluation of production efficiency is constrained by the absence of comprehensive, uniform measures of the output of hospitals (Fetter, Youngsoo, Freeman, Averill, & Thompson, 1980, p. x).

Donabedian (1973, p. 252) states that "the product of health resources" may be defined in three ways: 1) services produced; 2) episodes of illness "appropriately cared for"; and 3) increments (or decrements) in health "depending on whether one used a "process" or "outcome" approach in assessing the products of hospitals. Conceptually, Donabedian (1973, pp. 249-253) proposed that from the process oriented perspective the product of the system is medical care (services produced); conversely, from the outcome approach, the process of providing services is viewed as an intermediate step and instead changes in health status are emphasized as the real output measure. Donabedian proposed that the remaining measure, episodes of illness appropriately treated (cases), was a synthesis of the previous two approaches because "appropriateness" becomes an inherent measure of productivity. Similarly, Feldstein (1967, pp. 24-25) advocated the use of cases treated as a measure of output as it accounts for the relationship between length of stay and cost per patient day. The limitations inherent in the use of this measure of hospitals' output include: 1) the definition of what is "appropriate"; 2) problems in delineating discrete episodes of illness in association with corresponding episodes of care; 3) problems of comparability of morbidity states; and 4) fixed costs for standby services (e.g., empty beds, ambulatory services) (Donabedian, 1973, pp. 251-253; Feldstein, 1967, pp. 24-25).

Assuming that an episode of illness (case), appropriately treated, is the unit of hospital production selected, it then follows logically that variances in hospitals' roles and/or the nature of the case-mix (i.e., age, sex, type, stage of illness) may result in differences in the services produced and the resources used. In the following sections, research in this area is reviewed.

Determination of Differences in Hospitals' Outputs. During the last decade, a consensus has evolved that case-mix is the most direct measure of output differences across hospitals which are related to variations in the use of resources (Evans, 1971 & 1972; Lave & Lave, 1970 & 1971; Klastorin & Watts, 1980). Case-mix data (the relative proportions of different cases a hospital treats) has been used primarily in investigating resource consumption rate differentials within a population of hospitals (Evans, 1971; Feldstein & Schuttinga, 1977; Schumacher, Horn, Solnick & Cook, 1979). Fetter et al., (1980) proposed a broader use for case-mix data in such areas as utilization reviews, prospective reimbursement for hospital budgeting, and regional planning. A major deterrent in the use of this method of analysing output differences is the difficulty in establishing comprehensive and precise measures of case-mix that incorporate the numerous dimensions of this variable. Approaches to case-mix measurement can be broadly grouped into two main categories: 1) surrogate measures of case-mix, and 2) diagnostically based case-mix aggregates.

The pioneering work in the use of surrogate measures of hospital case-mix was performed by Feldstein (1961), who demonstrated a linear relationship between cost data and the number of patient days, which he identified as proxy measures of hospital output. In recognition of the multi-product nature of hospital output and in a desire to obtain an indication of the quality of these products, Lave and Lave (1970) expanded and refined Feldstein's surrogate measures; they employed hospital size, as measured by the number of beds, and variables to represent teaching status and location (urban vs. rural) in estimating average cost functions.

Carr and Feldstein (1967), in an endeavour to determine the effect of hospital size on the cost of providing inpatient care, used eight different proxy measures of the capability of hospitals to produce different services. This method was expanded by Berry (1974), who used dummy variables, to indicate the presence of absence of 40 different services in order to investigate the inter-relationships among hospital size, average cost and scope of services available.

At the same time, other researchers were advocating the use of diagnostic specific aggregates as the preferred approach to measuring case-mix differences across hospitals. Seminal research in the use of diagnostic aggregates of case-mix was initiated by Feldstein (1968) in a study of the British Health Service. Noting substantial variation in the proportional composition of the types of illnesses treated in different hospitals, Feldstein aggregated all admissions to hospitals into nine general diagnostic service groups (i.e., general medicine, general surgery, paediatrics, obstetrics, gynecology, ears-nose-throat, traumatic and orthopedic surgery, other surgery, and other general) and used the relative proportions of cases treated in each category to account for variances in operating costs. Lave, Lave and Silverman (1972) verified the utility of Feldstein's diagnostic-specific approach in determining hospital output differences.

A refinement in the use of the diagnostic-specific measures of output was advanced by Evans (1971) who investigated the effect of diagnostic- and age-sex-specific case-mix data on the dependent variables, average cost per case and average cost per day, for 187 Ontario Hospitals. The results of this study supported the concept of diagnostic and age-sex adjusted measures of hospital output. Evans (1971, p. 210) noted that large hospitals had higher costs per case, even when adjustments in length of stay (LOS) were "allowed for" by its inclusion as a separate independent variable; he concluded that this "raises the possibility that hospitals' ALOS is not a sufficient representation of efficiency in throughput" and as such may mask the potentiality that more severely ill patients, within different diagnostic aggregates, may be treated in larger hospitals.

Evans and Walker (1972) investigated in more depth the issue of varying case-mix complexity by employing entropy proposed by information theorists, as a measure of case severity in British Columbia. Use of the complexity measure, and the diagnostic and age-sex aggregate case-mix measures accounted for 81% and 84%, respectively, of the total variance in cost differences across hospitals. Based on these results, Evans and Walker emphasized that the "pattern of discharge diagnoses is the critical determinant of inter-hospital variations in cost per case and cost per day" (1972, p. 399).

An alternative approach to measuring case-mix complexity was developed by Thompson, Fetter, & Mross (1975). Discharge data was categorized in 383 diagnostic related groups (DRGs) (Fetter et al., 1980; Mills, Fetter, Fiedel, & Averill, 1976). Each of the 383 DRGs were deemed to reflect homogenous groupings of diagnostic cases with respect to: 1) resource use (output utilization) as measured by ALOS, and 2) medical meaningfulness as defined by medical experts based on clinical considrations (e.g., primary and secondary diagnoses, primary and secondary surgical procedures, age) (Fetter et al., 1980, pp. 12-13). The relative complexity of different types of cases was linked to the costs incurred in providing care. This methodology revealed that substantial differences existed in the case-mix of hospitals that were "apparently" fulfilling "similar roles" in the health care system; there were significant differences in the amount of resources used by different hospitals in treating similar cases, particularly medical and surgical sub-specialty (Thompson et al., 1975, p. 305).

By combining the key elements from the preceding two research studies, Horn and Schumacher (1979) developed a comprehensive approach to measuring the various components of case-mix. Following the information theory perspective employed by Evans and Walker (1972), Horn and Schumacher (1979) conducted a study based on complexity scores for each of the 383 DRGs (Thompson et al., 1975) using patient discharge data. Aggregate case-mix complexity measures were calculated for each hospital (Schumacher et al., 1979). It was concluded that case-mix complexity has two distinct components: 1) a concentration component, and 2) a risk or severity component. Each of these two components was identified as a significant predictor of cost per case across this hospital population. In addition, the results indicated that "hospital descriptors" (e.g., bed size, occuancy rates, educational programs, scope of technological facilities) "had little predictive effect on cost per case" when used in conjunction with measures of case-mix complexity (Schumacher et al., 1979, p. 1047).

As indicated by the review of the preceding literature, both proxy and diagnostic-specific, aggregate measures of case-mix have been effective in identifying differences in the output of hospitals and in accounting for variances in the use of resources across these hospitals. Nonetheless, Klastorin and Watts (1980) expressed concerns regarding the validity of such approaches, which are of relevance to this study. In assessing the construction of scalar measurements of case-mix proportions, Klastorin and Watts (1980) questioned the validity of assuming that different diagnostic categories can be weighted in an additive form and the appropriateness of using linear mathematical functions for aggregating the vector representing case-mix proportions. These investigators then queried whether or not the relationship among the elements of these aggregation indices was sufficiently similar across all units (e.g., hospitals or time periods) to justify using the same aggregation procedures for each hospital (1980, p. 679). Use of Q-type factor analysis to test for linear functional homogeneity with respect to resource use cast "doubt on the existence of a single set of empirically derived weights that would be valid for the construction of a linear index over an entire hospital population suitable for evaluating the appropriateness of variable hospital resource consumption rates" (Klastorin & Watts, 1980, p. 685). In response to the concerns identified by Klastorin and Watts (1980), hospital classification studies based on a multivariate approach have been conducted as an alternative to determining differences in hospital output by ascertaining the existence of functional homogeneity within different hospital populations.

Approaches to Hospital Classification. Hospital classification methodologies have been developed on the premise that the determination of resource allocation and the evaluation of efficiencies in the use of these resources, for different hospitals, are valid only insofar as comparisions are made among hospitals producing a similar output: in other words, serving a similar case-mix (Bay, Nestman & Leatt, 1981). Preliminary work in hospital classification focused on the use of proxy measures of hospital output as determined by differences in the number of services (e.g., laboratory, X-ray, paediatrics, intensive care, associated with a hospital. Using the total number of services provided by a hospital (Carr and Feldstein, 1967) or the assessment of the different patterns of acquisition of these services (Berry, 1973; Edwards, Miller & Schumacher, 1972) as the basis for establishing homogeneous categories, a relatively consistent pattern of hospital groupings emerged. Analysis revealed that high levels of internal homogeneity existed among hospitals for each service category in terms of general operating characteristics (e.g., length of stay, number of beds, occupancy rates, cost per patient day). The resulting categories approximated a continuum of acute case hospitals ranging from a large number of "basic service" hospitals, with the lowest values relative to the preceding characteristics, to a small number of "community service" hospitals, yielding the highest values (Berry, 1973; Carr and Feldstein, 1967). Further analyses indicated that average costs per patient day increases proportionately with the scope of services in hospitals (Carr and Feldstein, 1967, p. 160; Edwards et al., 1972, p 309). In assessing these results with respect to determining the most cost efficient hospital size, Berry (1973 & 1974) concluded that:

"A more fundamental question is what is the optimal mix of complexities of scope of services, or what is the optimal mix of types of hospitals." (1973, p. 12).

The results of studies which employed more comprehensive proxy measures of hospital output, in conjunction with the use of clustering algorithms, supported the findings of the preliminary hospital classification studies (Lance & Contandriopoulos, 1981; Phillips & Iyer, 1975). Although the type of hospital population and methodologies varied substantially, the results indicated a relatively consistent configuration of homogeneous groups of hospitals. Trivedi (1978, pp. 262-263) described the resulting clusters of hospitals as ranging from "primary" type hospitals characterized by their relative frequency, rural location and predominance of general practitioners on staff, through "secondary" type hospital groups, to "tertiary" type hospital groups which were few in number and were primarily large, metropolitan, teaching hospitals with a preponderance of subspecialty physicians on staff. Significant costs and length of stay differences among the various groups of hospitals were noted (Trivedi, 1978).

Developments in the measurement of hospital output using diagnostic specific aggregatres and the evolution of computerized analytic procedures encouraged further refinements in hospital classification methodologies. Preliminary work in this area was performed by Lave and Lave (1971) who compared the relationship between hospital characteristics (e.g., number of beds, teaching status, scope of services) and diagnostic specific measures of output (aggregated according to the 17 broad ICDA categories) in investigating role differentiation among hospitals. Lave and Lave (1971, pp. 36-38) concluded that: 1) case-mix varies significantly across hospitals; 2) a small group of common diseases account for a large proportion of total inpatient days; 3) the case-mix of a specific hospital is relatively stable over time; 4) hospital characteristics (proxy measures of output) were deemed inappropriate surrogates for approximating case-mix variations; and 5) some hospitals treated proportionately more common cases than others, although most hospitals treated at least a portion of all disease types. It was proposed that a definite pattern of role differentiation existed with the more common medical and surgical cases being concentrated in small, non-teaching, rural hospitals; the concentration of more complex cases (as equated with costs based on Blue Cross reimbursement criteria) appeared to coincide with the increasing number of beds, scope of services, and teaching capabilities of the hospitals. Similar patterns of role differentiation among some Canadian hospitals were documented by researchers who classified hospitals according to diagnostic-specific PAS patient discharge data (Bay et al., 1981; Cleaver, 1979) and a combination of diagnostic specific PAS data and proxy measures of hospital output (Lance and Contandriopoulos, 1981).

An ecological approach, which is dependent on the use of a regionalization model, is the last approach to classifying hospitals reviewed in this study. This model is based on the premise that a large geographic area can be subdivided into health care regions according to traditional utilization patterns (Lusk, 1975; World Health Organization, 1980, pp. 3-5). Within these regions, health care institutions are conceptualized as corresponding to a functionally differentiated hierarchy of facilities serving the varying health needs of the regional populations (McNerney & Riedel, 1962, p. 4). This model is designed to ensure economically efficient volumes of production and optimal use of resources by distributing commonly needed services throughout the regions and centralizing specialized services (Finkler, 1979a, p. 264; Roemer, 1979, p. 72). Recognition of the functional overlap across different groupings of hospitals is a unique characteristic of this hospital classification methodology. Health care decision makers are gradually acknowledging the utility of regionalization as a framework for assessing many of the current problems (such as rapidly evolving, costly technology, demands for accessibility, and cost containment) affecting the health care system (Roemer, 1972; World Health Organization, 1980).

Although the perspective differs, the general form of the ecological approach to classifying hospitals is relatively consistent. Roemer (1979) outlined an ecologically derived "pyramidal" model for depicting the functional differentials existing among hospitals in one region. Three specific groups of hospitals, varying in their scope of service, size, distribution, and prevalence, were identified including: 1) several small (50-100 bed) hospitals, located close to the various concentrations of people throughout the region and capable of treating common health needs (e.g., minor injuries, normal childbirth, common infections); 2) a smaller number of intermediate hospitals (100-300 beds), more centrally located in order to serve the populations of subregions already served by several smaller hospitals, and capable of treating more difficult cases (e.g., serious injuries, infections, abdominal surgery); and 3) a centrally located, large regional medical centre (500-1000 beds), associated with a medical school, participating in research, and providing a full range of highly specialized services for the treatment of the most complex illnesses (e.g., cardiac and brain surgery, cancer treatment). Roemer (1979) noted that the intermediate and central referral hospitals would retain a proportion of beds to serve the lower level needs of the regional population living in close proximity to these hospitals. A similar conceptual model for grouping the health needs of a regional population and the specific types of facilities associated with each level - "primary, secondary and tertiary" - was presented by Blum (1976, p. 92). Blum posited that the average cost per unit of service escalates as a patient moves from primary to the secondary level, and peaks in tertiary level facilities. Schultz (1970) developed a conceptual planning model for grouping health facilities that reflects the basic dimensions of the previous models; he postulated that patients are willing to travel further to receive more complex levels of care due to the inverse relationship between net social benefit (benefits minus costs) and opportunity costs (e.g., travel time, travel costs), and the unique nature of illness.

Basic to the use of an ecological framework for classifying hospitals is the implicit, although unstated tenet, that in response to contextual variables (i.e., the balancing of cost containment against public demands for accessibility) a natural pattern of functional differentiation among hospitals evolves. This pattern of functional differentiation corresponds to the three tier, successively inclusive groups of hospitals proposed. Empirical validation of this assumption and the precise nature of the resulting hospital categories has been limited.

In an early, innovative study, Mountin, Pennell, and Hoge (1945) developed an integrated hospital system subdivided into regional service areas as a background for evaluating the distribution of health facilities in many U.S. states. The system for each state was evolved through the <u>subjective</u> designation (based on the trade centre concept) of selected cities as "primary hospital centers" which were seen as serving the high level referral needs of populations in surrounding counties. Depending on the sophistication of services available, hospitals in other counties were then denoted as "secondary" or "isolated" centres. Mountin, et al., were the first researchers to enunciate the standard of 4.5 hospital beds per 1000 persons. Of these 4.5 beds, they proposed that 2.5 beds per 1000 persons be maintained in "isolated hospital centers", and the remaining hospital beds be allocated to "secondary centers" and "primary centers" to serve the referral needs of these sub-populations. It was determined that a "primary hospital center" should have .5 extra beds per 1000 population for all counties comprising the region in order to meet the high level referral needs.

A modified ecological approach to clustering 123 Chicago hospitals was employed by Morrill and Earickson (1968) in an effort to account for differences in patient travel distances associated with each facility. Using factor analysis, 99 variables were reduced to nine independent measures of hospitals. Three of these dimensions were related to such ecological determinants as the demographic and spatial characteristics of its service area and accounted for 28% of the variance. When the hospitals were classified according to these dimensions, several groups of hospitals were formed and each group was characterized by different utilization patterns.

A single empirical study was located by the investigator that employed an ecological approach to grouping hospitals. Sharp and McCarthy (1971) classified hospitals into three groups - "local, subregional, and regional" - according to their relative ability to attract patients. Although the functional overlap of these three classes of hospitals was alluded to by Sharp and McCarthy (1971), investigation of the degree of overlap (i.e., the proportion of hospital beds in subregional and regional hospitals dedicated to providing lower level services), which is a significant dimension of the ecological approach to categorizing hospitals, was not pursued.

The foregoing review of the literature related to hospital classification research illustrates that a relatively consistent pattern of functional differentiation appears to exist among acute care hospitals which is linked to variations in resource requirements. The evolution of hospital classification methodologies has closely paralleled developments in the measurements of hospital outputs. Difficulties in defining the nature of the product supplied by hospitals has constrained the development of these classification methodologies.

2.2.4 <u>Summary</u>

An overview of the major approaches to classification methodologies in the health care system was provided, not only to place this classification study in perspective, but also to clarify some of the concepts used in the methodology. The major points related to the use of classification methodologies in the health care system are noted.

1) The value of classification methodologies in health care is directly related to their usefulness in condensing large amounts of data into relevant, manageable sources of information essential for the successful administration of such a complex system.

2) Within the context of the health care system, the grouping of patients according to common disease etiologies - Disease Classifi-

cation - is the most well-established and widely used classification system; it provides an objective approach to estimating the similarity of care needs and resource use across different patient populations. However, this approach has limitations in dealing with chronic diseases or degenerative conditions since etiology alone is usually insufficient to prescribe care requirements.

3) Patient classification methodologies are divided into two approaches: 1) classification of patients by "Types of Care" (inter program or facility), and 2) classification of patients by "Levels of Care" (intra program or facility). Both approaches are important components of the conceptual base for this study.

4) Various measures of hospital output have been developed ranging from single proxy measures to complex diagnostic-age-sex specific, aggregate measures of case-mix severity.

5) Investigation of the relationship between various measures of hospital output and costs generally support the proposition that a continuum of acute care hospital groups exists, ranging from primary care hospitals which treat common illnesses with a relatively low per unit cost, through secondary hospitals, to the other extreme of a few, large, technologically complex, tertiary care hospitals which have the highest per unit costs.

6) Advocates of the ecological approach to hospital classification maintain that a pattern of functional differentiation exists when hospitals are classified according to differences in outputs.

2.3 Patient-Origin-Destination Research

The importance of assessing the output of the health care system in relation to the consumption patterns of its service population (market) are widely acknowledged. Three different approaches to establishing a service base for assessing health care production - consumption relationships have evolved: 1) optimal/normative; 2) administrative; and 3) ecological/empirical (Shonick, 1976, p. 62; Taliaferro & Remmers, 1972, p. 337). Using the normative approach, the boundaries of the service area (market) are prescribed by the researcher/planner with the objective of optimizing health care delivery in relationship to some predetermined criteria. With the second approach, administratively created service bases are arbitrarily defined to correspond to pre-existing political boundaries, thus emphasizing administrative expediency without regard to the health care phenomena under consideration. The third alternative, the ecological approach, involves the use of actual consumer origin-destination flow patterns in assessing utilization. Basic to the optimization and administrative approaches is the delineation of the geographic component of the service base, which is then used to identify the relevant aspects of the associated population; conversely with the ecological approach the service base is outlined and then the associated geographic area is derived.

The health care sector in most industrialized countries is characterized by freedom of patient choice; this allows patients and physicians to transcent administratively convenient geographic boundaries and to establish utilization patterns based on individually defined criteria, which may differ widely from optimal criteria established at the aggregate level. Therefore, patient origin-destination methodologies appear to offer the greatest potential for establishing a framework to analyse health care consumption behaviour. Raasok (1979) conducted an extensive review of patient origin-destination studies as a basis for assessing nursing home utilization patterns in Alberta. As identified by Raasok (1979, p. 34) and others (Griffith & Wellman, 1979, p. 295; Schonick, 1976, p. 65; Studnicki, 1975a, p. 14), research based on patient origin-destination methodologies can provide insight into three different aspects of health care utilization: 1) analysis of utilization patterns; 2) delineation of institution-specific or area-wide service populations and service areas for planning purposes; and 3) determination of efficiency and effectiveness in the allocation of resources for area-wide control and planning.

2.3.1 Analysis of Health Care Utilization Patterns

Spatial analyses of patients' care-seeking behaviours have provided empirical data which tend to substantiate the existence of a functionally differentiated network of institutions in the health care system that are associated with different patient utilization patterns. As well, the aspects of travel time and travel distance have been repeatedly identified as intervening variables which have a significant impact on patient utilization behaviours.

In a seminal study of health care utilization patterns undertaken in 1945, Ciocco and Altenderter (1945) employed a patient origin-destination methodology to determine the interdependence relationships among several counties with regard to the provision of medical services. The degree of dependency of one locality upon the medical services of another area was assumed to be a function of the flow of patients. Two ratios were developed to quantify these flows using birth statistics. The analysis revealed that approximately 18% of the counties functioned as centers of medical care for 66% of the other counties; the remaining centres exhibited both inward and outward flows which confounded their destination as either "centres" or "dependent" counties. However, these results were limited by the fact that researchers analysed only obstetrical services.

Other researchers have assessed health care utilization patterns using patient origin-destination data. As indicated previously, Morrill and Earickson (1968) used patient origin-destination data to group hospitals and to study related utilization behaviours as a function of distance. Morrill and Earickson (1968, pp. 26-34) concluded that:

> These distance relations demonstrate a meaningful, consistent, and significant behaviour. They support the notion of a hierarchical spatial structure of hospital distribution in the Chicago area. The distance relationships described were so homogeneous within a hospital type, and so consistently different between groups, that such findings can be safely incorporated into models of hospital use.

A simplified cross-tabulation analysis of patient origin-destination data for hospitals in a primarily rural area (Sharp and McCarthy, 1971) showed a relationship between the concept of hierarchical differentiation among hospitals (Morrill & Earickson, 1968) and the geographically based concept of medical service interdependence (Ciocco & Altenderter, 1945). Based on the "radial mileage distance" travelled by the patients and the general "ebb and flow" of patients, three categories of geographic regions were identified: 1) regions demonstrating a net importation of patients; 2) regions experiencing a balance between the import and export; and 3) regions yielding a net export of patients to other regions. The results indicated that the "import" regions were dominated by the presence of "regional" hospital centres which attracted patients from throughout the immediate region and other surrounding regions. "Export regions" were characterized by the presence of "local" hospitals which catered to the less complex health needs of the local population. Travel distances appeared to be directly related to utilization patterns, in that patients who travelled longer distances tended to have significantly longer lengths of stay when hospitalized.

Elaimy (1969) investigated the relationship between patient utilization patterns and the functional nature of hospitals by assessing case-mix complexity, the technical sophistication of hospitals, and patient travel distances/times. Significant positive correlations were obtained for measures of patients' case-mix complexity, the technical adequacy scores of the admitting hospitals, and the corresponding patient travel distances/times. Shonick (1976, p. 71) notes that the Elaimy (1969) study supports the proposition "that a good deal of self-regulated regionalization, regarding the matching of case severity to hospital sophistication, already exists in the natural referral patterns of physicians and in choices made by patients."

Efforts have been made to measure the degree of regionalization which is apparent in the care-seeking behaviours of patients. Gordon, Weldon, and MacLean (1974) reported that utilization patterns for general hospitals in Nova Scotia between 1967 and 1972 showed that there was an increasing tendency for the seven health care "regions" to rely on the teaching hospital in the "referral region" for the provision of inpatient services to their respective populations. In addition, "out of region" patients admitted to the "referral region" hospitals had consistently longer ALOS in comparison to patients hospitalized within their region of origin, which the authors atttributed to the possibility that more seriously ill cases were being referred (Gordon, Weldon & MacLean, 1974, pp. 51-52). It was determined that approximately 80% of all residents obtained hospital services within their region of origin (MacLean, Weldon, & Gordon, 1974, p. 193). In order to quantify the degree of regionalization occurring, MacLean et al., (1974) and MacLean and Weldon (1977) developed a "self-sufficiency index". This index was intended as a measure of the inter-regional flows associated with patients using hospitals outside their area of origin.

While the tendency for patients to minimize distance in seeking care has been recognized, Shannon, Bashshur, and Metzner (1969) found that travel time, especially in urban areas, is a more significant measure of the accessibility associated with utilization than travel distance. Marninson (1964) demonstrated the effectiveness of using a "time circle", instead of the usual distance circle, to represent differences in patients' accessibility to health care associated with the construction of new transportation routes. Similar results were identified in other origin-destination based studies (Drosness, Reed, Lubin, 1965; Lubin, Drosness & Wylie, 1965). These results were collaborated in a subsequent study by Drosness & Lubin (1966).

In addition to illustrating the relationships among patients' care seeking behaviours, functional differentiation across hospitals and travel distances/time implications, patient origin-destination methodologies have been used to investigate the influences of other contextual variables on utilization. In a comprehensive assessment of factors affecting obstetrical utilization in urban areas, Studnicki (1975b) found that, while distance minimization factors were operative, other organizational variables (i.e., location of physicians, hospital admission privileges, the relative importance of obstetrical services to the hospital) and ethnic characteristics of the patients also affected utilization patterns. Investigation of changing organizational practices was the focus of a study by Zuckerman (1977) who analysed relevant changes in hospital utilization patterns in response to an increased emphasis on outpatient services and the implementation of new funding policies. In an innovative patient origin-destination study of nursing home utilization patterns, Raasok (1979) indicated that organizational characteristics (i.e., type of ownership, size, accreditation status) appeared to influence utilization patterns and that demographic characteristics (e.g. sex, marital status) varied between geographically differentiated (urban vs. rural) user sub-populations.

Socio-economic factors affecting care-seeking behaviours have also been the focus of some patient origin studies. Bosanac, Parkinson, and Hall (1976) determined that "inaccessible populations" (located outside a 30 minute travel time criterion) were characterized by socio-demographic attributes which were among the key correlates of high health care utilization. Other selected examples include the study by Miner, Greene, Salber, and Scheffler (1978) concerning the influence of racial origin, level of income, waiting time, and travel times on utilization of medical services by rural inhabitants, and a study by Bashshur, Shannon and Metzner (1971) regarding the influence that socio-economic variables (e.g., race, education, income) and spacial variables (i.e., office location) have on the selection of hospitals, physicians, and dentists.

Analysis of the preceding literature reveals that two predominant factors influence patient utilization behaviour: 1) the tendency towards distance minimization (measured by actual distance or travel time, and 2) the tendency for utilization patterns to correspond to a regionalized concept of functional differentiation across hospitals. With the possible exception of the Elaimy study, it is apparent that investigation and quantification of this unique relationship have been limited. Further analyses of this area may prove useful in determining resource allocation by levels of care for acute care hospitals.

2.3.2 Delineation of Service Areas and Service Populations

Implicit in the mandate of any service organization is the responsibility to meet the needs of its "constituency". Evaluation of the efficiency and effectiveness with which an organization fulfills this responsibility is directly related to a clear delineation of the nature of its respective constituency. On a conceptual level, it is generally accepted that the constituency of a health care facility is comprised of two related but different components: 1) the geographically based "service area", and 2) the demographically derived "service population" (Griffith, 1978, p. 16; MacStravic, 1978, p. 31). Patient origin-destination methodologies have been extensively used by researchers in operationally defining the service area and service population components.

The Poland-Lembcke study (1962) was the earliest, significant study to empirically define hospital service areas by incorporating actual utilization patterns (based on patient origin-destination data) (Griffith, 1972, pp. 68-79; Shonick, 1976, pp. 65-67). The methodology applied the untested normative assumption that, in adapting to existing ecological variables, the provision of hospital services in the study area followed a regional hierarchical approach; within this context, Poland and Lembcke perceived a hospital service area as being:

> a distinctly defined geographic area containing one or more hospitals that supply most of the hospital care needs of its inhabitants. The shape of such a district is decided by its size and drawing power in relation to the surrounding hospitals. (Shonick, 1976, p. 66)

Using patients' postal addresses obtained from hospital records, Poland and Lembcke (1962) amalgamated townships to form equal-likelihood service areas such that the boundaries corresponded to those points at which there was an equal probability that patients would seek care at a specific hospital as opposed to travelling to all other institutions. Analysis of patient flows within the resulting service areas indicated that the "technical sophistication" of a hospital was directly related to its ability to draw patients over longer distances. Also, those patients with more complex diseases tended to travel further for hospital services. In response to these results, Poland and Lembcke (1962) concluded that patient utilization data provides the means for measuring the degree of regionalization in the provision of health services.

In contrast to the multi-hospital, area-wide perspective of the preceding study, subsequent researchers have tended to emphasize the delineation of service areas from the individual hospital's perspective: commonly referred to as defining a hospital's catchment area (Shonick, 1976, p. 68). Using this approach, Meade (1974) delineated individual hospital service areas based on techniques similar to the Poland-Lembcke study. Patient origin-destination data were coded by patients' zip code addresses. Separate hospital service areas were then formed by clustering those zip code areas from which at least 60% of the respective populations requiring hospital services attended a similar hospital. Although the service areas thus constructed varied significantly in size and shape, the results confirmed that over 75% of the study population was served in the nearest hospital. Relative long-term stability in the size and form of rural hospital service areas was substantiated by Meade (1976) when the study was repeated using the same population.

Other researchers have been preoccupied with the difficulties in defining hospital catchment areas in densely populated urban areas. Cardwell (1964) attempted to rationalize the planning for Metropolitan Chicago by dividing the city into census tracts and then amalgamating those census tracts with similar utilization patterns into larger hospital service areas. Droness, Reed and Lubin (1965) developed a computer based spatial representation of hospital service areas which depicted the admissions to each urban hospital as a percentage of total admissions to all hospitals from each census tract. Similarly, Morrill and Earickson (1968) and Studnicki (1977) integrated census tract data and patient origin-destination data to establish service areas for specific hospitals in densely populated urban areas. Results from many of these studies demonstrated the existence of overlapping service areas with wide variations in size and form. In urban settings these service areas were not always congruent with the minimization of travel distance/time. This difficulty in defining a hospital's service area in urban settings was related to the increased mobility and eclectic preferences of consumers in urban areas where there is a preponderance of different hospitals (Griffith, 1972, p. 82; Zimmerman, 1975, pp. 46-48).

The aforementioned researchers used patient origin-destination data to delineate hospital service areas with the implicit assumption that the geographic boundaries of the hospital service areas were the optimal basis for identifying the second component of the service constituency, the service population. Cognizant of the weaknesses in this "all of nothing" approach, other researchers employed patient utilization data to develop an alternative approach to determining service populations which need not be defined within the context of a corresponding hospital service area.

Griffith (1972) pioneered this research in response to observed weaknesses in the "equal-likelihood" approach to determining hospital service populations of Poland and Lembcke. Griffith (1972) criticized the inflexibility of the equal-likelihood methodology in that:

> the procedure approximates by a dichotomous decision (in the service area or out) what is actually a much more fluid reality, a continually decreasing tendency to use a given hospital as the distance from it grows. (p. 75)

He noted that this methodology was particularly remiss in accounting for two particular types of service populations: 1) the secondary referral populations in rural areas, and 2) the diffuse utilization patterns of densely populated urban areas (Griffith, 1972, p. 74). To overcome these limitations, Griffith (1972) developed the relevance and commitment indices for identifying hospital service populations. The relevance index (R.I.) was defined as the percentage of total patients from a selected small area admitted to each of the study hospitals (Griffith, 1972, p. 76) or the percentage tendency of residents to use a particular hospital. Griffith, therefore, proposed that it was possible to obtain a graphic illustration of a hospital's service area. The second index, the commitment index (C.I.), was defined as the percentage of total admissions to a particular hospital which originate from each small area under study (Griffith, 1972, p. 76) or as a measure of the tendency of a study hospital to serve different small areas.

It appears that the service constituency concept may have utility in this study as a means of grouping hospital districts based on similarities in patient utilization patterns. Delineation of small area resource consumption rates as a basis for control and planning is a related aspect of this concept that is presented in the subsequent section.

2.3.3 Analysis of Resource Utilization for Control and Planning

Insofar as comprehensive, valid measures of the health needs of patients and the outputs of hospitals have been unavailable, assessment of the equitable distribution and efficient use of resources has been constrained. As a result, researchers have substituted analyses of differences in resource use across comparable populations, based on patient origin-destination data. The utility of this approach lies with the division of the region under study into service constitutencies which are small enough that significant variations in utilization-resource allocation patterns and interactions are evident, and yet large enough to provide valid and stable measures of these interactions (Shannon et al., 1969, p. 144; Struening, 1974, p. 510; Wennberg & Gittelsohn, 1973, p. 1102).

Traditionally ratios, such as the number of hospital beds/1000 persons and costs per patient day, were calculated for a large region and used as average standards for assessing resource allocation and performance. Implicit in the use of such ratios for planning and control purposes is the assumption that "all hospital beds are homogeneous with respect to the associated services provided and that all segments of the population are homogeneous with respect to the services needed" (Cardwell, 1964, p. 108). Furthermore, the application of these ratios to a large geographic area without adjusting for unique sub-regional, demographic variations, and inter-regional patient flow patterns compromises the validity of these measures (Joffe, 1979, p. 350). Ciocco and Altenderter (1945) recognized the significance of these limitations some years ago:

> To obtain a correct picture of the medical resources available to a community, certain developments must be made in the statistics of both the population and the medical facilities of the community. If the facilities of a community are utilized by persons in surrounding places, the population and facilities of these locations should be grouped with those of the original communities before ratios of the facilities to population are computed. (p. 973)

Wennberg and Gittelsohn (1973), in attempting to overcome these limitations, undertook a classic study of small area variations in resource consumption. Wennberg and Gittelsohn (1973) found that "there are wide variations in resource input, utilization of services, and expenditures among neighbouring communities" which are not initially apparent when assessed from an aggregate regional perspective (p. 1007). Their methodology made allowance for factors such as: patient mobility, physician referral patterns, patient preferences, and regionalized referral services. Subsequent research by Wennberg (1979) and Joffe (1979) supported the findings of Wennberg and Gittelsohn (1973). The wide variations in utilization indicate considerable uncertainty and lack of concensus about the effectiveness of different types and amounts of health services, and thus the provision of hospital services often appears unrelated to the needs of the residents (Joffe, 1979; Wennberg, 1979; Wennberg & Gittelsohn, 1973).

Griffith (1978) expanded the commitment and relevance indices methodology for defining service populations into a comprehensive evaluation framework designed to investigate small area discrepancies in resource utilization. Within this framework, the R.I. is employed to delineate hospitals' service populations. Next, variation in the allocation/consumption of hospital resources are determined on a per capita basis. Griffith (1978, p. 17) determined that increased specificity in the application of this framework was feasible by developing R.I.s and service populations for all inpatient areas (e.g., obstetrics, paediatrics, surgery). This framework relies heavily on age-sex-specific population data, particularly in regard to children (0-14 years), females (15-44 years), and the general population (15-44, 45-64, 75+ years); age-sex associated variations in utilization patterns may then be assessed in relation to age-sex adjusted service populations (Griffith, 1978, p. 17; 1972, pp. 94-95). To enhance the utility of this framework for planning, Griffith (1978, pp. 18-21) advocated that hospitals which have overlapping population bases (as reflected by the respective R.I.s) be clustered for purposes of collaborative decision making. Extreme variations in per capita rates of mortality, morbidity, and resource allocation could then be used as a measure for examining quality of care. Griffith (1978, p. 14) noted that the utility of this framework was compromised by its failure to account for variances in case-mix severity/complexity and the associated cost differences across study hospitals.

Other researchers (Bay & Nestman, 1980 & 1982) extended the application of Griffith's (1972) relevance and commitment indices methodology in order to derive a model for measuring resource consumption on a per capita basis that closely parallels Griffith's (1978) framework. Bay and Nestman (1980) in testing their model identified that if these indices are used in determining resource allocation, the following two assumptions must be made: 1) homogeneity exists in the amount of hospital resources used/allocated per patient for all the hospitals serving one region, and 2) homogeneity exists in the number of patients treated per unit of hospital resources used for all districts served by one hospital. The existence of functional differentiation among hospitals and selective referral patterns by physicians could invalidate these assumptions since the proportions of patients requiring different levels of care might then vary among hospitals (Bay & Nestman, 1980). When the model was applied to utilization data for Alberta hospitals, a high rank correlation (.8) was achieved for estimates of resource consumption using the two different measures (Bay & Nestman, 1980). However, in comparing resource consumption rates, it was noted that:

> Resource consumption or allocated rates vary more among hospitals than among districts, perhaps due to effects of the referral system and types of services offered. (Bay & Nestman, 1980, p. 693).

Comprehensive planning proposals based on the detailed assessment of requirements for specific hospital services or different "levels of care" have been strongly recommended, as opposed to using general planning objectives such as beds/1000 persons (Berry, 1974; Florida Task On Institutional Needs, 1978, p. 15). Small area analyses of resource consumption, using patient origin-destination methodologies, have proven effective in relating the specific health needs of patients to resource consumption. Nonetheless, extension of these methodologies as a basis for planning equitable distribution and efficient use of resources has not been widely discussed in the literature.

Anderson and Wertz (1977), in an innovative study, employed utilization data to determine the appropriate number of beds for a new sub-speciality paediatric hospital designated to meet the tertiary care requirements of British Columbia residents. This study was unique in that two distinct service populations were identified: 1) the "referral population", defined as a population so distant from the tertiary referral centre (Vancouver) that it was "unlikely to seek non-referred or secondary referral care from the institutions in the tertiary care centre", and 2) the remaining population, in close proximity to the tertiary referral centre, was called the "urban" population (1977, p. 408). Disease specific utilization rates, were calculated for all patients originating in the referral service region; the proportions of total cases for each diagnostic rubric which required hospitalization in the referral centre were then determined. These utilization rates were considered to be indicative of the actual requirements for tertiary paediatric services and were subsequently applied to hospital utilization data for urban patients with similar diseases in order to determine the "frequency of tertiary referrals" in the urban service population. As a result, current and future paediatric tertiary care bed requirements were projected for the entire province. Anderson and Wertz (1977) estimated that approximately 12-14% of the beds should be allocated to tertiary care. Although this latter study deals only with requirements for tertiary levels of care, the approach used would appear to have relevance in designing a methodology for determining the percentage of primary, secondary, and tertiary level hospital beds that are currently being used in Alberta.

2.3.4 Summary

It would appear that an analytic approach based on patient origin-destination methodologies may be of value in determining the number/percentage of hospitals beds in Alberta related to the provision of primary, secondary, and tertiary level services. Specifically, patient origindestination methodologies may be useful in investigating the following areas:

1) Assessment of the general pattern of patient utilization in order to determine if a current ecological utilization pattern exists.
2) By employing the R.I. and/or C.I. based approach to determining service areas, it may be feasible to group hospitals and service regions according to similarities in patient utilization patterns.
3) Patient origin-destination methodologies may serve as a basis for measuring the differences in patient flow across these service regions related to the provision of primary, secondary and tertiary care beds in hospitals.

2.4 Relevant Alberta Based Research

Previous researchers have investigated selected aspects of the Alberta health care system, concerning hospital classification and patient utilization patterns, and hospital operating costs, which are particularly relevant to the development of this study.

2.4.1 Classification of Alberta Hospitals

Bay, Westman and Leatt (1981), in endeavouring to formulate an equitable scheme for evaluating resource utilization for Alberta acute care hospitals, investigated the feasibility of using clustering techniques to classify hospitals according to the similarity of their case-mix. Case-mix data were obtained from the PAS separation abstracts for 123 provincial hospitals in 1976. Although this study focused on the classification of hospitals as a single entity, the results obtained indicate that a high level of homogeneity exists across specific groups of Alberta hospitals when analysed on the basis of diagnosticspecific case-mix.

2.4.2 Utilization Analyses Using Patient Origin-Destination Studies

The Alberta Health Care System Study was undertaken in 1972 under the auspices of the Alberta Hospital Services Commission (Paine, 1975, vol. 14, Paine & Wilson, 1974, pp. 63-76). The purpose of the study was to compile a comprehensive data base on acute care hospital utilization in Alberta for planning and performance evaluation. Based on an assessment of patient origin-destination data (identified by census subdivisions), patient flow patterns associated with individual hospitals were analysed in order to determine: 1) hospital catchment populations; 2) regional referral centres; 3) larger geographic regions associated with each regional centre; 4) imbalances (excess/deficit) in hospital bed allocations per designated "geographic region" (based on 4.5 beds/1000 population); and 5) variances in hospital operating costs associated with case-mix differences (categorized according to 11 broad H-ICDA groupings).

Their analyses revealed the existence of six regional hospital centres, namely, Edmonton, Calgary, Grande Prairie, Red Deer, Lethbridge and Medicine Hat which served over 90% of the patients living in their immediate geographic areas. The geographic boundaries of these regional areas were established by amalgamating those census areas whose residents were served primarily by one of the six regional centres. The case-mix analyses indicated that significant variations existed across hospitals in the percentage of case-mix distribution, average length of stay, and average cost per case treated. Case-mix accounted for 91.2% of the total variation in cost per case. A major limitation was apparent in the methodology used by Paine (1975) in that the geographic unit of analysis employed (i.e., the census subdivisions) did not coincide with the hospital district boundaries. (Teixeira, 1975). Census subdivisions may encompass more than one hospital while others do not contain a hospital. Thus, it is difficult to evaluate patient flow across individual hospital districts.

Bay and Nestman (1980) developed an alternative approach to delineating service areas and service populations for Alberta hospitals. This methodology, based on an extension of the R.I. and C.I.s, was modified to establish a per capita measure of resource allocation. This model delineated a hospital's service population without direct relation to a specific geographic area. At the same time, patient utilization could be related to hospital districts, if required, for comparative purposes. Results of this analysis indicated that inter-hospital and inter-district resource consumption/allocation varied considerably across the province. Comparative interpretation of these results was limited, since the methodology failed to account for variations in case-mix severity and referral patterns across hospitals and districts.

In assessing the studies by Paine (1975) and Bay et al., (1975), Teixeira (1975) noted that the approach to defining service areas used by Paine (1975) was mathematically equivalent to the R.I. model employed in the Bay et al., study: the respective outcomes, however, were significantly different. Teixeira's conclusions related to acute care hospital utilization and the selection of an approriate geographic unit of analysis:

> The province should be divided into geographical areas such that utilization data can still be broken down by area, and, there is only one institution within the boundaries of each area as far as possible. In the case of larger urban centres, this would be impossible.
>
> The number of geographic areas should be equal to or greater than the number of institutions in the province, where each cluster of urban hospitals counts as one institution. (Teixeira, 1975, pp. 71-72).

2.4.3 Cost Functions in the Alberta Hospital System

An econometric study was conducted by Wallace (1975) to assess the relationship between interhospital short-run average nursing administration, nursing service cost, and general administration costs for Alberta acute care hospitals in 1971. Hospitals were classified according to bedsize based on the assumption that case-mix was similar for each group. Ordinary least squares regression analyses were completed using the output measures of the average number of admissions per bed for each group of hospitals. The results of Wallace's study were inconclusive in that a consistent relationship between costs and hospital size was not obtained.

2.4.4 Summary

From this overview of Alberta research, it is apparent that hospitals are differentiated by the nature of their service populations and the diversity and complexity of their associated case-mix. In this regard, patient origin-destination methodologies using hospital districts as the geographic unit of analysis appear to provide the most appropriate means for investigating these variations in utilization patterns.

2.5 Comments and Conclusions

In considering the preceding literature review related to the use of utilization data, the following conclusions are advanced.

1) Given the abstract nature of health needs and the diverse, complex, interactive factors which influence how these needs are manifested, analysis of actual utilization patterns represents the most objective, comprehensive, and realistic approach to measuring health needs and planning for the efficient use and equitable distribution of health resources.

2) As a result of the continuing escalation of health care costs resulting from the proliferation of new, sophisticated technologies, efforts must be made to rationalize the allocation of resources to provide maximum benefits to the greatest number of people.

3) Analysis of hospital outputs has shown that hospitals do provide different levels of services which are associated with differences in patient utilization patterns.

4) The predominant characteristic of patient utilization is the apparent tendency for people to seek hospital services in close prox-

imity to their residence, particularly in rural areas. The tendency for patients to travel further for hospital services seems closely linked to the seriousness/uncommon nature of the illnesses. Patient origin-destination studies have been used extensively in the analysis of hospital utilization behaviour and have tended to illustrate that a natural configuration of functional differentiation exists among hospitals for a large study area in response to patients' utilization patterns and other contextual variables (i.e., cost containment). As such, it would appear that patient origin-destination methodologies may be useful in measuring a hospital's resources (beds) which are dedicated to providing different levels of services.

CHAPTER III

DEVELOPMENT OF THE ANALYTIC FRAMEWORK

The main purpose of this study was to develop a methodology for estimating area-wide and hospital-specific bed utilization rates by three levels of care - primary, secondary, and tertiary based on observed care-seeking patterns. The study was divided into three phases: 1) development of the analytic framework; 2) derivation of bed utilization profiles by three levels of care (hereafter known as the Bed Utilization by Levels of Care Profile or BULP)[1] for each acute care hospital in Alberta; and 3) evaluation of the BULPs using operating cost data. The methodology and results associated with each part are presented in Chapter III, Chapter IV, and Chapter V respectively.

The analytic framework for this study is delineated in Chapter III under five sections pertaining to: 1) general research strategy; 2) data sources; 3) geographic basis of analyses; 4) classification of hospitals and districts; and 5) summary.

3.1 General Research Strategy

Albeit a complex and difficult endeavour, an empirically validated methodology for classifying, by levels of care, those patients who are hospitalized in acute care institutions within a large study area (i.e., Province of Alberta) would provide valuable information for evaluating hospital resource allocations. Preferably, the research strategy for such a study would include a province-wide, cross-sectional examination of all hospital patients. Systematic assessment

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[1]For purposes of clarity and conciseness, commonly used terms and concepts in this study were abbreviated. These abbreviations are identified initially within the main text. Refer to Appendix A for a comprehensive list of these abbreviations.

and classification of these patients by an external panel of experts would yield a comprehensive standardized data base. Ideally, an area-wide patient classification system would be developed from this data base that would provide a basis for comparing the quantity of health care resources required by a particular hospital versus that required by other hospitals. As a result, provincial statistics, in terms of the number of patients served in each level of care, would be available for determining the allocation of future resources to hospitals in the study area.

While preferable in terms of the comprehensiveness of the data collected, implementation of a prospective, province-wide, cross-sectional patient survey is fraught with difficulties. Given the inexact scientific basis of medical practice, the assessment/classification judgment made by an expert panel would inevitably include a subjective component. When the collection of data is dependent on a degree of subjectivity, measurement problems are an inherent concern. Extensive logistical planning and a large financial commitment would be required to implement such a study. These difficulties increase significantly when the study population is located in 121 hospitals, scattered throughout a large, geographically diverse area, such as Alberta, that is susceptible to seasonal and climatic variations. Modification of the research design using probability sampling techniques would reduce the costs. Nonetheless, even with these modifications, a cross-sectional survey approach to classifying hospital patients by levels of care was deemed beyond the scope of this thesis due to the complexity of the research design, the high costs, and the logistical difficulties.

In view of the aforementioned constraints, a more limited, exploratory, and descriptive research strategy was adopted. Based on an in-depth analysis of previously collected government data, two models (denoted henceforth as Models A and B) were derived for estimating the number and/ or proportion of beds in each hospital occupied by patients requiring primary, secondary or tertiary level care (i.e., BULPs). To develop these models, geographic variations in patients' care-seeking patterns were measured and associated with differences in the levels of care provided by different hospitals.

The study was restricted to an analysis of utilization patterns involving the entire population of Alberta residents seeking inpatient services from all acute care hospitals in the province. The relationship of this study (indicated with darker lines) within a broader context is depicted diagramatically in Figure 1. A study of geographic variations in patient utilization patterns incorporates the direct impact of supply and demand variables as well as the indirect influence of political, social, technological, and environmental constraints. As illustrated (the dotted lines in Figure 1) and previously discussed, a comprehensive, patient-centered assessment is an alternative approach to investigating the relationship between the allocation of hospital resources and patient utilization by levels of care.

The analytic sequence followed in this research study is delineated in Figure 2. Patient origin-destination models were used to quantify patient flow patterns between hospitals and geographic areas. Concurrently and in accordance with the ecology/regionalization approach to analysing health care utilization, hospitals, and hospital districts in Alberta were classified subjectively into three classes

FIGURE 1

FRAMEWORK OF THE RESEARCH STRATEGY

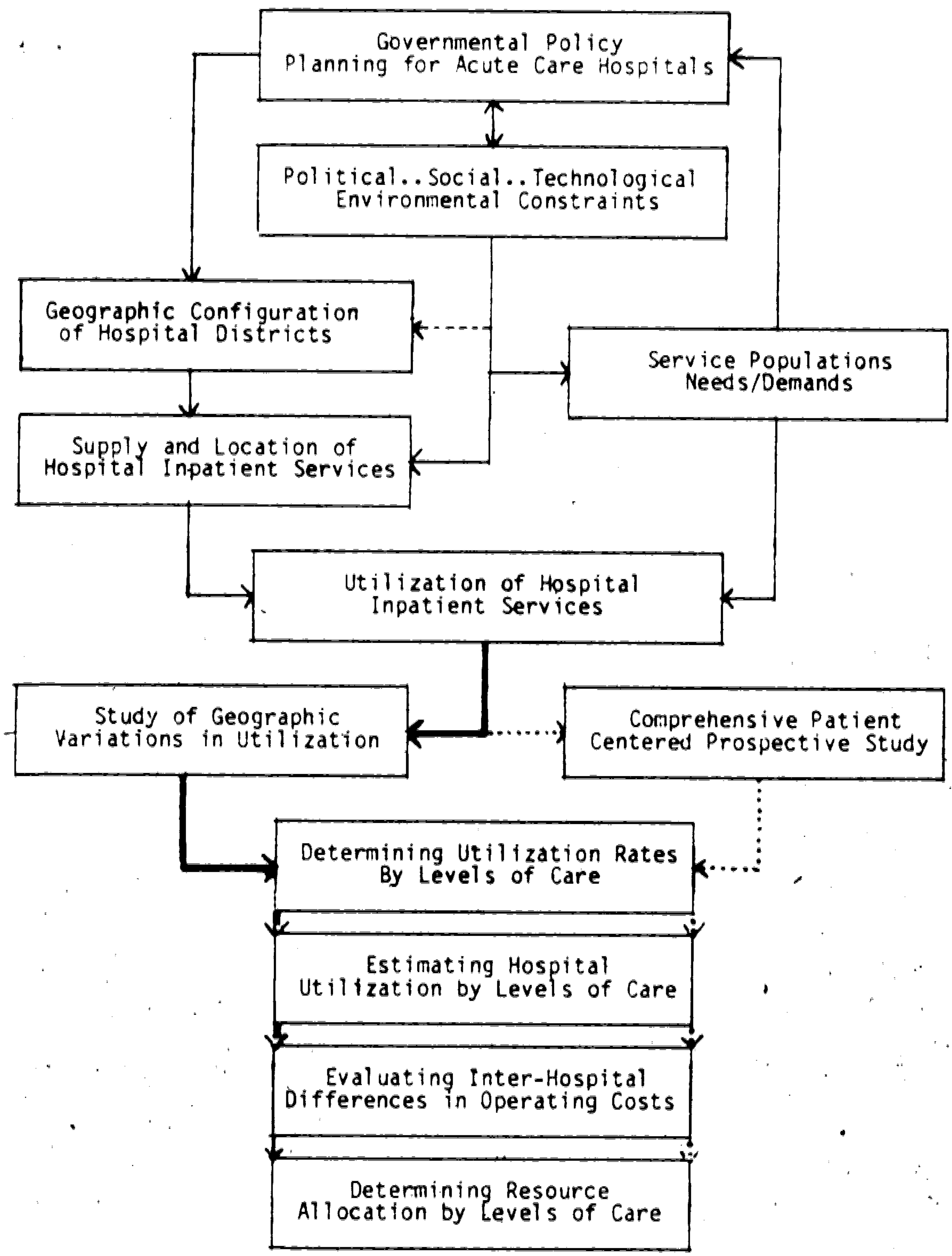
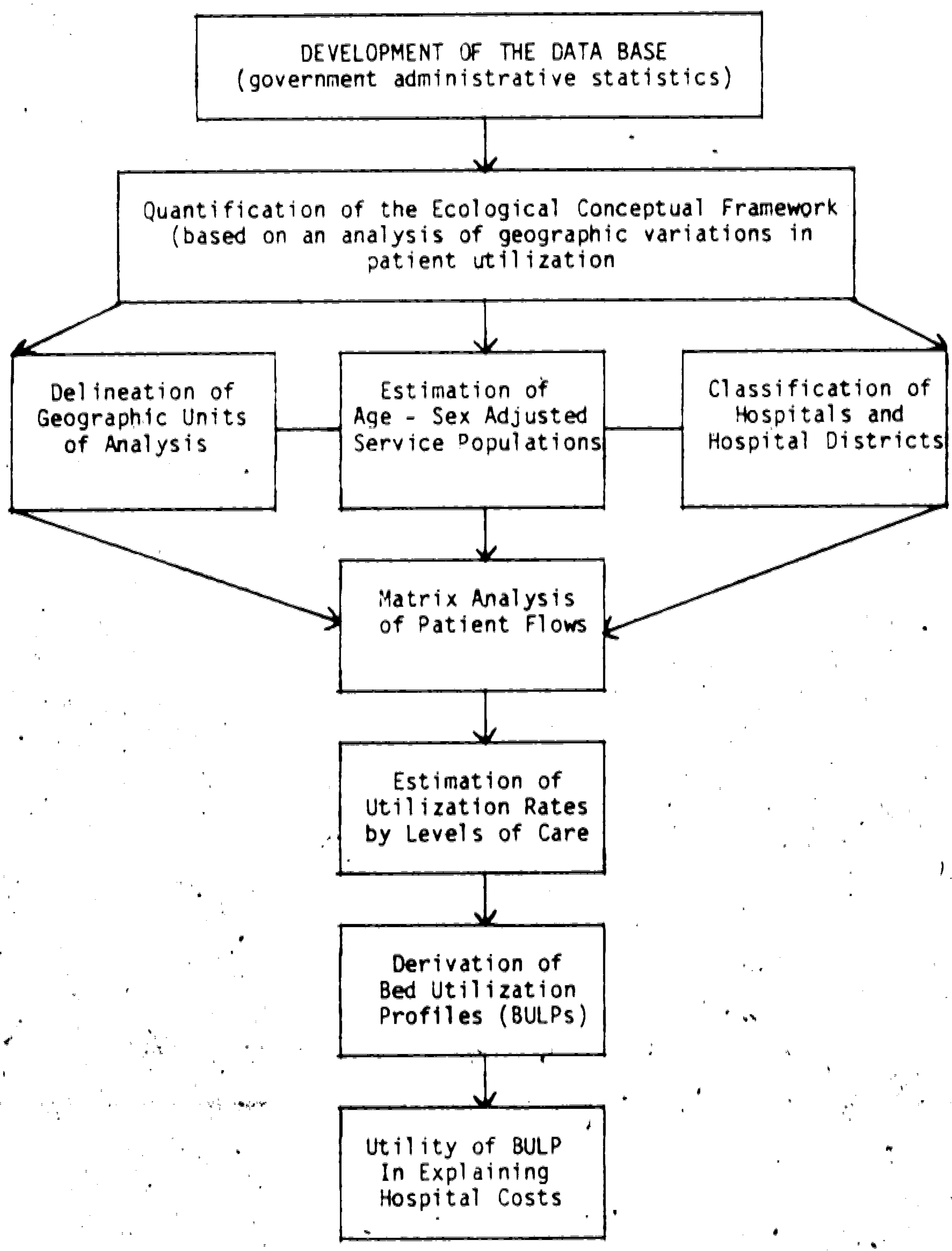


FIGURE 2

ANALYTIC SEQUENCE OF THE RESEARCH DESIGN



depending on the highest level of care provided in the hospital or available in the hospital district. These classifications were then substantiated from an examination of utilization patterns and information theory measures of hospitals' case-mix complexity. In the next phase of this study (Chapter IV), the results of a second series of patient origin-destination analyses, incorporating patient days (PDAYs) and/or separations (SEPs) associated with these aggregated hospitals and geographic areas, were used to formulate a bed utilization profile (BULP) for each hospital. The utility of this approach to quantifying hospital utilization by levels of care was evaluated in the final phase of the research study (Chapter V) by examining the relationship between operating costs and BULPs generated for Alberta hospitals.

The data base for this study was abstracted from administrative data regularly collected by Alberta Hospitals and Medical Care (AHMC). In order to increase the stability of the data base, the study period extended over 24 consecutive months (1977 & 1978). Although the data base encompassed two years, this study was considered cross-sectional in design insofar as it was based on specified data compiled on a predefined population within a single time period. Given the nature of the data base and the paucity of theoretical development or prior empirical research on this topic, an analytic framework based on inferential statistics (hypothesis testing) was deemed inappropriate. Instead, descriptive statistics were employed in this pilot, exploratory study.

3.2 Data Sources

Policy makers, government planners, and health administrators in Alberta have access to large quantities of routinely collected data.

In order to accommodate the financial and time restrictions imposed on this study, the research methodology was designed so that existing government statistics, namely PAS utilization data, population statistics, and hospital financial data, constituted the data base. Inherent in this decision was the desire to demonstrate the value of administrative data as a source of information for assessing the delivery of health services. The three types of administrative data used are discussed in terms of their origin, content, and limitations.

3.2.1 PAS Separation Abstracts

The primary data source consisted of PAS separation abstracts completed on all Alberta residents (adult and children) discharged from Alberta hospitals between January 1, 1977 and December 31, 1978. These data were obtained from AHMC, and represented the most recent, comprehensive, standardized, hospital utilization data available on a province-wide basis. A PAS separation abstract is a summary of a patient's medical record and contains the following demographic, diagnostic and treatment data: age, sex, date of admission, length of stay, hospital identification code, residence codes, diagnostic/operation codes (based on H-ICDA and CDC classifications), and numerous other data which were not used in this study. The patient's residence is coded according to the hospital district in which he/she originates; thus, each episode of hospitalization can be identified in terms of the patient's origin in one of these mutually exclusive and exhaustive geographic regions. (See Appendix B for a copy of the PAS separation abstract format).

PAS case abstracts are completed routinely by medical records personnel from each participating hospital in accordance with the criteria and data definitions established by PAS under the auspices of the Commission on Professional and Hospital Activities (CPHA). Although these personnel are trained in the use of the PAS standards for data collection, discrepancies may exist in interpretation or application of these criteria across different hospitals. The impact of these discrepancies is expected to be minimal given that: 1) information excerpted for this study is relatively "hard data" (e.g., length of stay, patient's age, hospital identification number), wherein subjective input and interpretation effects are minimized; 2) inclusion of the entire population in the study increases the probability that errors may balance overall; and 3) the study period was extended over 24 consecutive months to enhance the stability of the statistical estimates and thereby reduce the impact of isolated incidents (e.g., high staff turnover in a hospital's medical records department during a particular year).

The PAS abstracts for 1977 and 1978 provided utilization data on 782,882 separations from 121 acute care hospitals located in 103 hospital districts (hereafter denoted respectively as HOSP and DIST) in Alberta (see Appendix C for a list of these hospitals and districts). By limiting the scope of the study to residents of Alberta seeking inpatient services in provincial hospitals, utilization data were analyzed as if the province encompassed a closed hospital system. As such, it was assumed that utilization patterns of non-residents hospitalized in the province and residents hospitalized outside the province would have negligible impacts regarding the research outcomes. This assumption was necessary insofar as PAS utilization data for residents hospitalized outside the province were not readily available and the PAS residence codes for non-Albertans hospitalized in the study area were too general to be of value for the analyses based on patient origin.

A limitation in the data base emanated from the use of PAS statistics which were collected primarily for administrative and clinical purposes. The unit of the PAS file is a separation episode rather than a patient. As a result, PAS data are unable to account for the movement of patients throughout the hospital system (i.e., a series of hospitalizations linked to one episode of illness). Manual or computerized tracing of patients by identification number (i.e., Alberta Health Care Insurance Plan number) is conceivable, theoretically. However, to maintain patient confidentiality, identifiable patient codes were removed by AHMC before release of the files for this study. Consequently, according to PAS coding procedures, every patient admission, whether it involved transfer/referral from another hospital and/or readmission for treatment of the same disease episode is counted as an independent event (i.e., a new patient case). For example, a patient admitted first to a small rural hospital, subsequently transferred to a larger regional hospital, and finally admitted to a metropolitan teaching hospital would be counted as three patient separations, not as one continuous illness episode which utilized three hospitals. Thus, PAS utilization data may tend to overrepresent the number of cases treated at hospitals providing primary and secondary level services. To partially compensate for this limitation, analyses based on PAS data were calculated in PDAYs as well as SEPs for the 24 month time period, unless otherwise stated. PDAYs associated with each hospitalization would seem to be a more sensitive indicator of geographic variations in utilization patterns than SEPs.

3.2.2 Population Data

Standardized, province-wide, demographic data were required as a control for possible distortions in utilization patterns due to age-sex variations in regional and hospital service populations. Detailed age-sex population statistics, derived from the June 1, 1976 Canada Census and coded by DIST, were obtained from AHMC. The time lag between collection of the demographic data and the PAS utilization data may have contributed to minor over or under estimates when adjusting for age-sex differences in these service populations. Unfortunately more current, provincial population statistics were unavailable at the time these analyses were completed.

3.2.3 Hospital Financial Data

Hospital operating cost statistics comprised the remaining portion of the data base. These data were required to evaluate the utility of BULPs in explaining inter-hospital variations in operating costs. Financial data for each Alberta HOSP were abstracted from the Annual Return of Health Facilities - Hospitals Part One for the fiscal years ending March 31, 1978 and 1979. These data are submitted annually by each HOSP to the AHMC for administrative purposes and provide a summary of patient care activities and resources expended. A detailed description of these financial data is presented in Chapter V.

By integrating PAS utilization data, population demographics, and hospital financial data, a comprehensive data base was obtained with relatively minor costs for data collection. As identified, however, reliance on these previously collected administrative statistics in formulating the data base was associated with some specific limitations.

3.3 Geographic Variations in Hospital Utilization by Levels of Care

In this study, geographic variations in patient utilization patterns were analyzed with the objective of estimating BULPs for each HOSP in Alberta. The initial phase of this study involved the establishment of a framework for measuring these variations and relating them to different classes of HOSPs and geographic areas. Fundamental to the development of this framework was the assumption that the care provided by HOSPs serving a large area can be differentiated into three levels - primary (Level I), secondary (Level II), and tertiary (Level III). This assumption was derived from the ecology or regionalization approach (designated hereafter as the ecology approach) to assessing hospital utilization (proposed by Elaimy, 1969; Roemer, 1979; Sharp and McCarthy, 1971).

The analytic framework was based primarily on a patient origin destination analysis using the relevant index (R.I.) and commitment index (C.I.). As identified in the literature review, R.I. and C.I. have wide application. These indices can be used to: 1) quantify differences in patient flows between geographic areas; 2) identify service constituencies (i.e., service areas and service populations); and 3) determine regional variations in resource consumption. The first two applications of the patient origin-destination model were incorporated in the framework. In addition, results of these analyses were integrated with information theory analyses of hospitals' case-mix complexity in order to reconfirm the subjective classification of HOSPs and DISTs. These subjective classifications were made in accordance with the ecology approach to assessing hospital utilization from an area-wide perspective. In developing this framework, the following aspects were addressed: 1) establishment of geographic units of analysis; 2) assessment of geographic variations in utilization patterns; 3) derivation of age-sex adjusted service populations; 4) hierarchical clustering of HOSPs and DISTs to delineate large service constituencies; and 5) classification of hospitals and hospital districts based on the availability of levels of care.

3.3.1 Basic Geographic Units of Analysis

Use of a patient origin-destination model, as the basis for detecting differences in patient utilization patterns, necessitated that the province be subdivided into mutually exclusive and exhaustive geographic units. Ideally, these units would have equivalent geographic dimensions (e.g., size, shape, transportation system), would circumscribe homogeneous populations, and would encompass one HOSP per unit. In such a situation, atypical patient flows between geographic units could be attributed, with relative certainty, to differences in the levels of services provided by the various hospitals. Given the nature of the data base and the study area, this was unattainable. Instead, DISTs were selected as the basic geographic unit of analysis. The reasons for this decision are listed below.

1) Due to the historical evolution of the Alberta health care system, the boundaries of DISTs in the province were determined primarily to correspond to municipal taxation boundaries: substantive changes in this administrative orientation appears unlikely in the near future.

2) DISTs divide the province into 103 mutually exclusive and exhaustive geographic areas and corresponding populations. With the exception of the three urban DISTs (i.e., Edmonton, Calgary, and Lethbridge) and six rural DISTs, these DISTs encompass only one hospital.

3) PAS separation abstracts are coded to facilitate tabulation by DIST.

4) In Alberta, enumeration areas, the smallest area unit for recording Canadian census data can be clustered to correspond closely to the boundaries of these DISTs.

5) Included in the data base for this study are 782,882 PAS separation abstracts, spanning the province. DISTs, as the basic geographic unit for identifying patients' origins and destinations, are large enough that data analyses are manageable, and yet small enough that the data reduction does not obliterate significant differences in patients' care-seeking patterns. In view of these considerations, the investigator concluded that the 103 DISTs, although not ideal, were the most viable, basic geographic units of analysis for this study. These DISTs and associated HOSPs are illustrated in Figure 3.

3.3.2 <u>Geographic Variations in Utilization Patterns</u>

Within the context of this study, geographic variations in utilization patterns were equated with differences in patient's origin destination flows across different geographic areas. The patient origin-destination flow matrix developed by Griffith (1972, p. 75) was the framework employed in delineating flows of patients seeking care in Alberta HOSPs. As shown in Figure 4, this matrix provides a systematic approach to cross-tabulating patient utilization by origin (patient's residence by DIST) and destination (patient's care location by HOSP). Application of this framework to the data base produced a patient flow matrix consisting of 121 HOSPs by 103 DISTs. Each of the resulting 12,463 matrix cells represented the unique utilization pattern associated with the interaction of patients originating from a specific DIST

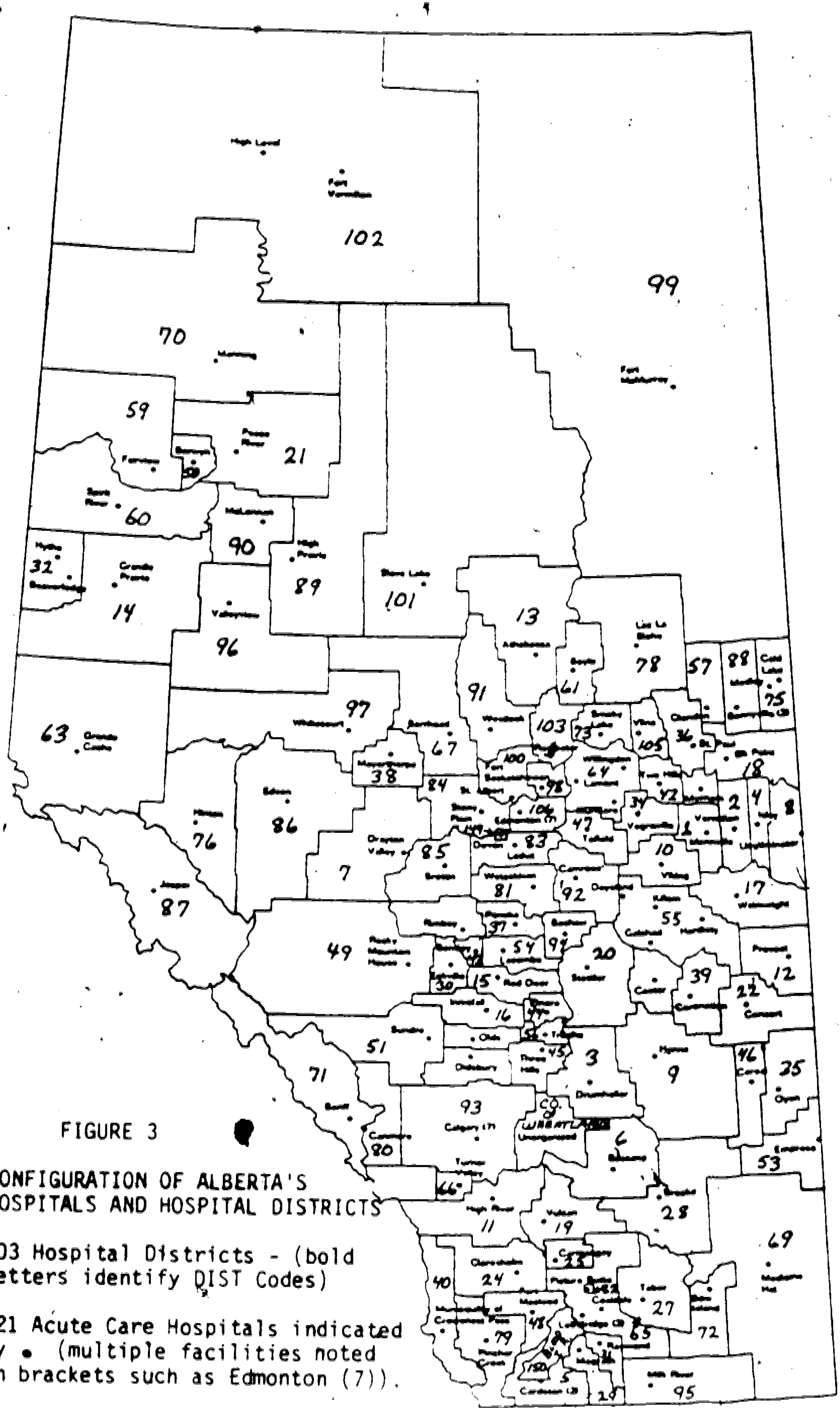


FIGURE 3

CONFIGURATION OF ALBERTA'S HOSPITALS AND HOSPITAL DISTRICTS

103 Hospital Districts - (bold letters identify DIST Codes)

121 Acute Care Hospitals indicated by • (multiple facilities noted in brackets such as Edmonton (7)).

FIGURE 4

PATIENT ORIGIN-DESTINATION FLOW MATRIX

Hospital (Destination)	Hospital District (Origin) 1	2 3 .... j	 103	Row Total
1	a_{11}	a_{1j}	$a_{1,103}$	$\sum_j a_{1j}$
2				
3				
i	a_{i1}	a_{ij}	$a_{i,103}$	$\sum_j a_{ij}$
121	$a_{121,1}$	$a_{121,j}$	$a_{121,103}$	$\sum_j a_{121,j}$
Column Total	$\sum_i a_{i1}$	$\sum_i a_{ij}$	$\sum_i a_{i,103}$	$\sum_i \sum_j a_{ij}$

Where: a_{ij} = the number of admissions to hospital i from the area of patient origin (hospital district) j

$\sum_j a_{ij}$ = total number of patients in hospital i

$\sum_i a_{ij}$ = total number of patients from district j in hospitals

$\sum_i \sum_j a_{ij}$ = total number of patients in all hospitals in the province.

and the care received at a specific HOSP destination. Patient utilization frequency divided by column sums indicate the relative tendency of patients originating in each DIST to travel to different HOSPs (R.I.). Alternatively, patient utilization counts divided by row sums indicate the relative tendency of a particular HOSP destination to provide care or allocate resources to patients from different hospital districts (C.I.). Consistent with Raasok's (1979) extended application of the relevance and commitment indices (developed by Griffith, 1972 & 1978; Bay & Nestman, 1980 & 1982), these indices were used in this study to quantify geographic variations in patients' utilization patterns. Two sets of R.I. and C.I. were calculated based on PDAYs and SEPs (formulae for deriving R.I. and C.I. are contained in Appendix D). As explained in subsequent sections, these indices were also used to: 1) aggregate DISTs and HOSPs to form larger, geographically contiguous, service constituencies, and 2) to substantiate subjective classifications of HOSPs and DISTs according to levels of care associated with each.

3.3.3 Derivation of Age-Sex Adjusted Service Populations

Reliance on geographic variations in hospital utilization as the basis for estimating the number of primary, secondary, and tertiary level beds required in the study area was predicated on the assumption that the health needs of the population were homogeneous (i.e., basic requirements for different levels of hospital services were similar). Previous researchers have identified that inconsistencies in health needs (as evidenced by regional differences in utilization rates) were related frequently to age-sex disparities. To control for this potential source of uncertainty, the population of Alberta was subdivided to coincide with the boundaries of the 103 DISTs; these geographically discrete service populations were then adjusted to ensure uniformity by age and sex. In deriving the age-sex adjusted service populations for each DIST (denoted hereafter as SP), the methodology used by Bay and Nestman (1980, pp. 682-683) and Raasok (1979, pp. 66-68) was adopted. Two sets of data were required: age-sex specific census data (1976) for each DIST formed the demographic component and rates of resource utilization (average age-sex specific patient-days per capita), calculated from aggregated 1977 and 1978 PAS abstracts, were used to determine the appropriate weights for adjusting the census statistics. Additional adjustments to the SPs to account for regional discrepancies in socio-economic-demographic variables and the supply of health resources (e.g. hospital beds) were not attempted.

3.3.4 Geographic Clusters of Hospitals and Districts

Following the selection of the basic geographic units of analysis the 103 DISTs), these DISTs and the related HOSPs were then clustered to form larger, conterminous, geographic service constituencies. These clusterings produced a three-tiered hierarchical configuration of service areas which facilitated the development of two series of patient origindestination matrix analyses to measure geographic disparities in patient flows by level of care. (These matrix analyses are discussed in Chapter IV). The geographic clusters comprising each tier were identified as follows: 1) DISTs (Tier 1); 2) REGIONs (Tier 2); and

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[2]Refer to Bay and Nestman (1980, pp. 682-683) or Raasok (1979, pp. 66-68 for a detailed description of the approach used in this study for deriving age-sex adjusted service populations. This approach is referred to by some researchers (e.g., epidemiologists) as the indirect method for achieved age-sex adjusted populations.

3) REFERRAL AREAs (Tier 3). In forming these clusters the following criteria were applied: 1) actual care-seeking patterns (based on patient origin-destination analyses of PAS PDAYs and SEPs for 1977-78 using R.I.s and C.I.s); 2) the natural geographic integration of some DISTs; 3) provincial transportation routes; and 4) natural commercial trade patterns. The geographic form and rationale for developing each tier of clusters is outlined below.

Tier 1 - Districts. As identified, 103 DISTs were selected as the basic geographic units of analysis. At the district level it was difficult to compare inter-district care-seeking patterns of Albertans because three DISTs (i.e., Lloydminister Municipal Hospital District, County of Wheatland Area, Blood Indian Reserve) did not encircle a "local" HOSP (destination) and nine DISTs encompassed multiple "local" hospitals. To resolve this difficulty, the three DISTs were amalgamated with three adjoining DISTs (i.e., Islay, Calgary, Cardston respectively), and multiple hospitals within a DIST were assigned to one cluster (e.g., Lethbridge Municipal, St. Michael's General and Coaldale Municipal Hospital were assigned to the Lethbridge General Hospital District). These aggregations at the district level reduced the 103 DISTs and 121 HOSPs to 100 district clusters with corresponding clusters of hospitals.

Tier 2 - Regions. Geographic variations in patient flows tend to be blurred in urban areas due to the proximity of several hospitals offering similar services and the resulting overlap in service populations. In addition, urban hospitals serve as "referral" centres for other districts' populations and as the "local" hospital to urban populations. In this study, this referral phenomenon was exploited in order to estimate "local" utilization rates for urban populations and "non-local" (referral) utilization rates for rural populations. To analyse these relationships, the 100 district clusters were aggregated to form six large, mutually exclusive and exhaustive geographic service constituencies. The six regional constituencies were labelled Grande Prairie (GP), Edmonton (ED), Calgary (CL), Red Deer (RD), Lethbridge (LB), and Medicine Hat (MH). Each constituency included an urban centre: the configuration of these REGIONs is shown in Figure 5.

Tier 3 - Referral Areas. At the provincial level, a third aggregation was undertaken to delineate self-sufficient service constituencies (i.e., areas where patient flows across boundaries were minimal). As a result, the six regions were clustered to form two large "super" constituencies, designated as the North Referral Area (NRA) and the South Referral Area (SRA), which essentially divided the province into halves (Figure 5.)

The relationship among these hierarchical clusterings of DISTs and HOSPs from an area-wide, geographic perspective is depicted diagramatically in Figure 6. These aggregations provided a framework for reducing the data base and comparing patient flows from different geographic perspectives.

3.3.5 Classification of Hospitals and Districts by Levels of Care

To complement the geographic framework for identifying variations in patients origin-destination flow patterns, a framework for relating these variations to the levels of care available in HOSPs and related DISTs was developed. While various authors have advocated the utility of "classifying" hospitals by levels of care based on the ecology app-

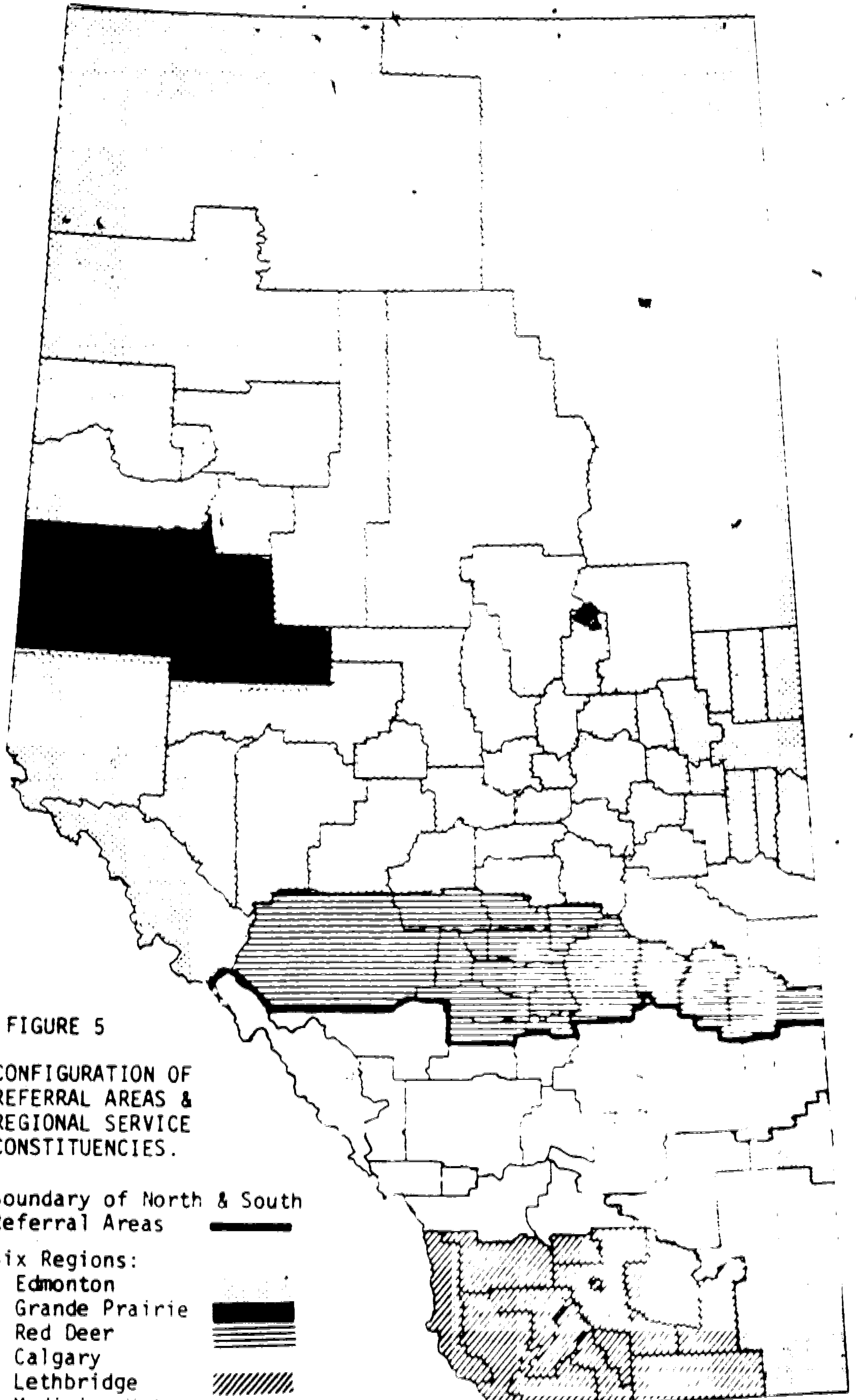


FIGURE 5

CONFIGURATION OF REFERRAL AREAS & REGIONAL SERVICE CONSTITUENCIES.

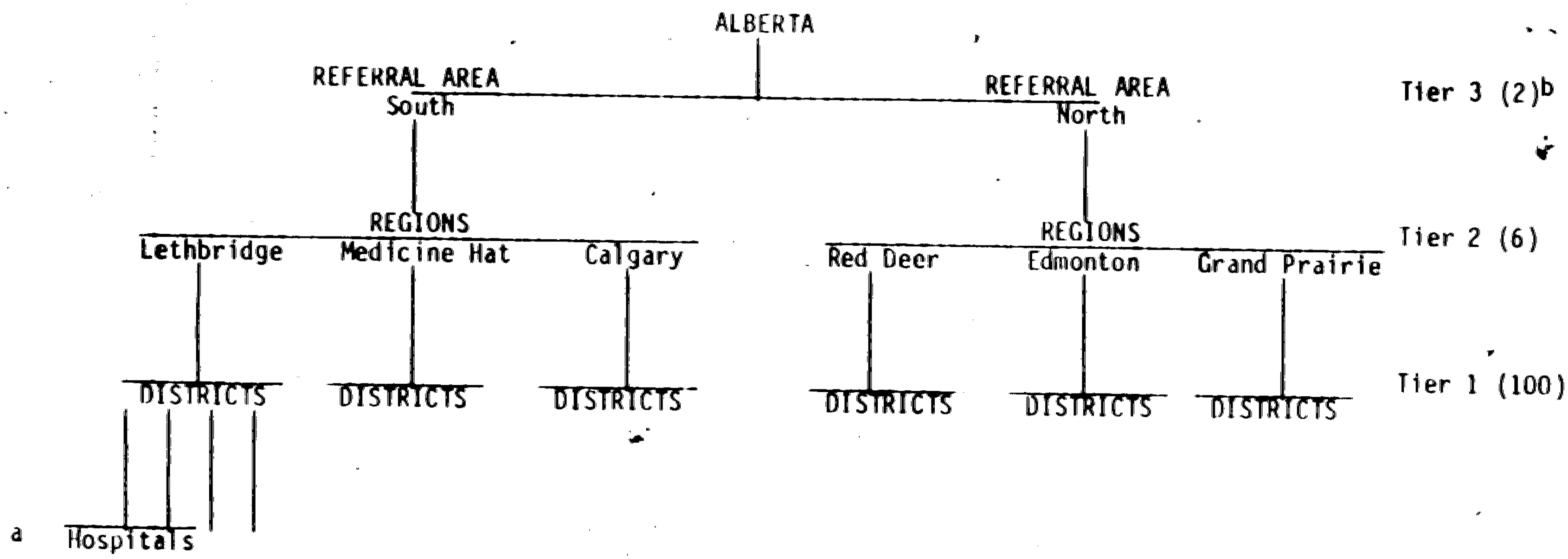
Boundary of North & South Referral Areas

Six Regions:
- Edmonton
- Grande Prairie
- Red Deer
- Calgary
- Lethbridge
- Medicine Hat

FIGURE 6

HIERARCHICAL GEOGRAPHIC CLUSTERING OF DISTRICTS AND HOSPITALS

BASED ON PATIENT FLOWS AND GEOGRAPHIC CONTINUITY



[a] Hospitals within each geographic service constituency are grouped to conform to the three Tiers of geographic clusters.

[b] The number of hospital <u>or</u> geographic clusters for each Tier are noted in brackets.

roach (e.g., Mountin et al., 1945; Roemer, 1979; Schultz, 1970; Shonick, 1976), the investigator was unable to locate comprehensive, empirically validated criteria for deriving "ecology" classifications. Therefore, in accordance with the results of studies which investigated some concepts of the ecology approach (e.g., Anderson & Wertz, 1977; Elaimy, 1969; Morrill & Earickson, 1968; Poland-Lembcke, 1962; Sharp & McCarthy, 1971), the investigator classified HOSPs and DISTs based on a subjective assessment of the levels of care available. The assessment involved a comparative consideration of the general characteristics of HOSPs (e.g., size, location, teaching activities, subspecialty services, service population size) from the HOSPs' perspective and then from the DISTs' perspective. The resulting HOSP and DIST classifications were then reconfirmed using different criteria which are developed in the following sections. The conceptual basis and results of these classifications are presented as follows.

Hospital Classifications. The 121 HOSPs throughout the study jurisdiction were first subjectively divided into three classes based on common knowledge about the hospitals and opinions of knowledgeable persons. Congruent with the ecology approach, these classes corresponded to a tri-level, hierarchical configuration of hospitals, characterized by: 1) increasing case-mix complexity; 2) the successively inclusive levels of care available as one progresses through the hierarchy of hospitals; and 3) overlapping service populations. The three groups of HOSPs were denoted as Class A, B, and C. These classes were designated as encompassing three levels of care, primary (Level I), secondary (Level II), and tertiary (Level III), following a successively inclusive format (i.e., Class A includes Level I; Class B includes Levels I and II; and Class C includes Levels I, II and III). Subjective assignment of the HOSPs by level of care was difficult, particularly for Class B and C hospitals. To substantiate these subjective classifications, patient utilization patterns and case-mix complexity associated with these HOSPs were also compared.

Commonalities among the utilization patterns of each DIST population were enumerated using R.I.s and C.I.s. A basic concept of the ecology approach, the tendency of local residents to use a local hospital, depending on the availability of all levels of care, was identified based on R.I.s of the local HOSPs to their local DISTs. Similarly, the tendency for hospitals to attract patients from larger geographic areas, in relationship to the increasing levels of services available and size (thus resulting in reduced allocations of resources/beds to local populations), was assessed using the C.I.s of local HOSPs to their local DISTs. The comparability of R.I.s was limited by the fact that some DISTs had more than one HOSP. In these instances the adjustment factor illustrated below was applied.

$$\text{Adjusted Relevance Index} = \text{R.I.} \times \frac{\text{Number of Beds in the DIST}}{\text{Number of Beds in the HOSP}}$$

If the adjusted relevance index exceeded 100%, it was automatically set at 100%.

In substantiating the subjective classifications, the tendency for increasingly complex cases from a large area to be concentrated in an increasingly smaller number of hospitals in the heirarchical configuration was quantified. An entropy measure was computed for each HOSP derived from the information theory approach to determining case-mix complexity (e.g. Evans & Walker, 1972; Horn & Schumacher, 1979). This approach to quantifying case-mix complexity was based on the premise that case complexity is an inverse function of the degree of concentration or the commonality of a particular disease among geographically dispersed hospitals. Case complexity weights were calculated first for each of the 188 CDCs using PDAYs and SEPs. A case-mix complexity value was then calculated for each HOSP by weighting the proportion of the HOSP's case-load for each diagnostic category by the complexity value for that category and summing the values over all diagnostic categories. This case-mix complexity measure is equivalent to the CMPXC1 measure developed by Evans & Walker (1972).[3] HOSPs with low case complexity values were equated with those which provide relatively commonplace (Level I) services to patients; alternatively, higher case complexity values were equated with technically and medically advanced hospitals which offer a range of inpatient services (Levels I, II, III). The conceptual relationship among the classes of hospitals, levels of care, service constituency measures and case-mix complexity values are depicted in Table 1.

As summarized in Table 2, the case-mix complexity values calculated for the HOSPs generally supported the subjective classifications. Although the mean complexity values for the Class A, B, and C hospitals were different, there was some overlap in the values. This occurred to a greater extent for the values derived from SEPS which do not weight

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[3]Evans & Walker (1972) developed three additional measures of case-mix complexity (i.e., CMPXC2) and specialization (i.e., SPCLC1 and SPCLC2) which according to their results were not as effective in explaining inter-hospital differences. Therefore, only the CMPXC1 measure was used in this study. Refer to Evans & Walker (1972) for a detailed description of the methodology.

TABLE 1

CONCEPTUAL RELATIONSHIP AMONG CLASSES OF HOSPITALS, LEVELS OF CARE, AND SUPPLEMENTARY HOSPITAL CLASSIFICATION CRITERIA

Hospital Classes	Levels of Care	Supplementary Classification Criteria		
		Service[a] Constituency		Case-Mix[b] Complexity Measure
		R.I.	C.I.	
A	primary (I)	Low	High	Low
B	primary (I) secondary (II)	Medium	Medium	Medium
C	primary (I) secondary (II) tertiary (III)	High	Low	High

[a] The formulae used to calculate the Relevance Index (R.I.) and Commitment Index (C.I.) measures of each hospital's service constituency are presented in Appendix D.

[b] These measures were derived from information theory measures of case-mix complexity developed by Evans and Walker (1972).

TABLE 2

DISTRIBUTION OF CASE-MIX COMPLEXITY MEASURES
(n = 121)

Statistic Measure[a]		Hospital Class A	B	C
Number of Hospitals		104	9	8
Minimum	SEP	0.653	0.933	1.074
Maximum		0.998	1.141	1.750
Mean		0.810	1.037	1.215
Standard Deviation		0.068	0.054	0.226
Minimum	PDAY	0.674	0.892	1.049
Maximum		0.973	1.026	1.357
Mean		0.815	0.993	1.165
Standard Deviation		0.060	0.040	0.130

Note.
These measures are based on the information theory approach to deriving hospital-specific case-mix complexity measures, developed by Evans and Walker (1972).

[a]The greater the numerical value, the greater the case-mix complexity.

each case based on severity (i.e., disease - specific variations in length of stay).

The relationships among the levels of care associated with the ecology approach, the three clusters of hospitals, and the secondary criteria (service constituency and case-mix complexity values) were used to reassess the initial subjective hospital classifications. Based on this information, the subjective classifications were finalized. Eight hospitals, four hospitals from each of Calgary and Edmonton, were categorized as tertiary (Class C). Nine hospitals, including the remaining hospitals from Edmonton, Calgary and other medium urban centres were classified as secondary (Class B). The remaining hospitals, 104 hospitals located in the rural areas, comprised the primary (Class A) hospitals (see Table 3).

District Classifications. Three groups of districts, Class X, Y, and Z, were determined by classifying each DIST in terms of the highest level of care (Level I, II, and/or III) available within its local HOSP(s). Regional self-sufficiency indices (developed by MacLean & Weldon, 1977) were then calculated for DISTs to confirm these categories. The self-sufficiency index (SSI) provides a numerical value which approximates the net flow of patients moving into or out of the DISTs by comparing the within hospital resources (beds) of a DIST utilized by all patients, regardless of origin, to the total resources used by patients originating from the same DIST. The formula is:

$$\text{Self Sufficiency Index (SSI)} = \frac{\text{Total PDAYs (SEPs) Generated by HOSP(s) within the DIST}}{\text{Total PDAYS (SEPs) Generated by Patients Originating in the DIST}}$$

TABLE 3

SUMMARY OF HOSPITAL AND HOSPITAL DISTRICT CLASSES BY LEVELS OF CARE

Hospital Class	Hospital[a] I.D. Code	Hospital[a] Name
C (tertiary)	15	Alberta Childrens
	16	Foothills Provincial
	17	Calgary General
	19	Holy Cross
	38	Dr. W.W. Cross Cancer
	43	Royal Alexandra
	44	University of Alberta
	303	Charles Camsell
B (secondary)	18	Salvation Army Grace
	20	Rockyview General
	39	Edmonton General
	41	Misericordia
	56	Grande Prairie Municipal
	71	Lethbridge Municipal
	72	St. Michael's Lethbridge
	79	Medicine Hat General
	92	Red Deer General
A (primary)[b]		the remaining 104 hospitals

District Class	Hospital District I.D. Code	Hospital District Name
Z (tertiary)	93	Metropolitan Calgary
	106	Metropolitan Edmonton
Y (secondary)	14	Grande Prairie
	15	Red Deer
	65	Lethbridge
	69	Medicine Hat
X (primary)[b]		the remaining 97 hospital districts

[a]The locations (hospital district) of these hospitals are identified in Appendix C.

[b]The names of these hospitals and hospital districts are listed in Appendix C.

A SSI of unity indicates that there was no net movement of patients. An index of less than unity denotes a net outflow of patients; a value greater than unity indicates a net inflow of patients to the DIST. The use of this index is based on the premise that inter-district patient flows were the result of patients travelling to obtain levels of care unavailable within their DIST of origin and not due to disparities in health needs. The relationships among HOSPs and DIST classifications, the SSIs, and inter-district patient flow patterns by levels of care are presented in Table 4.

Discrepancies between the initial classification of DISTs and the SSIs were reassessed with regard to the impact of transportation routes and climatic influences. The results of the final classification of the DISTs by level of care yielded: 1) two tertiary (Class Z) DISTs comprising Edmonton and Calgary hospital districts; 2) four secondary (Class Y) DISTs comprising Grande Prairie, Red Deer, Lethbridge and Medicine Hat hospitals districts; and 3) 97 primary (Class X) DISTs encompassing the remaining rural hospital districts (Table 3). These classifications were consistent with the ecology approach to assessing utilization patterns.

Use of the ecology approach in classifying HOSPs and DISTs by levels of care, as presented in this section, was predicated on two basic assumptions. First, it was assumed that hospitals can be grouped into a three level hierarchical configuration consistent with their capabilities to provide different levels of care. Patient classification researchers have demonstrated that patients can be grouped according to their requirements for care. Analogously, other researchers employing various measures of hospital output have tended generally to group hos-

TABLE 4

CONCEPTUAL RELATIONSHIP AMONG HOSPITAL DISTRICT CLASSES, HOSPITAL CLASSES, SELF-SUFFICIENCY INDEX, AND PATIENT FLOWS BY LEVELS OF CARE

District Classes	Hospital[a] Classes	Self-[b] Sufficiency Index	Patient Flows by Levels of Care		
			Within	Outflow	Inflow
X	A	(<1) Outflow	I	II, III	-
Y	B	($\cong 1$) Inflow & Outflow	I, II	III	II
Z	C	(>1) Inflow	I, II, III	-	II, III

[a]The most complex class of hospital situated within the region. Less complex classes of hospitals may or may not be present.

[b]Index formulae are based on the methodology developed by MacLean and Weldon (1977). The conceptualized net movement of patients, associated with each class of district and having the greatest impact on the index, is noted.

pitals in three basic categories including: 1) numerous, small, primary care facilities which provide services for relatively non-complex cases; 2) several secondary or regional hospitals which provide a moderately broad spectrum of services; and 3) a very few tertiary hospitals, characterized by the relative complexity of their case-mix and their role as an academic health centre. Due to the scarcity of experienced medical specialists and allied health personnel, and the expense associated with technologically complex diagnostic and treatment facilities, it appears logical that facilities providing higher levels of care would be more limited in number and located in larger population centres in order to attain economies of scale (i.e., hierarchical configuration).

Second, it was also assumed that the provision of hospital services is successively inclusive: lower level services are available in hospitals providing higher level services. This assumption appears reasonable in view of the fact that: 1) given the nature of illness, most seriously ill patients require lower level services (e.g., basic blood work) as well as specialized services (e.g., blood gases) during their illness, and 2) more complex levels of care are characterized by increasing degrees of personnel expertise and technological innovation (e.g., intensive care units).

Based on these two fundamental assumptions, the ecology approach to assessing patient utilization was used to classify HOSPs and DISTs in Alberta by levels of care. As discussed, other concepts of the ecology approach were also measured in an attempt to substantiate these classifications.

3.4 Summary

In Chapter III a framework was formulated to provide the basis for achieving the main objective of this study: the development of a methodology for estimating area-wide and hospital-specific patient utilization rates by primary, secondary and tertiary levels of care, congruent with actual care-seeking patterns. An exploratory, descriptive research strategy was adopted, incorporating previously collected administrative data relating to acute care hospital utilization in Alberta for 1977-1978. A framework was derived for analysing geographic variations in hospital utilization by levels of care, based on an integration of the patient origin-destination model and the ecology approach to assessing hospital utilization. Using hospital districts as the basic geographic unit of analyses, R.I.s and C.I.s were employed to quantify geographic variations in patient flow across the study jurisdiction. Based on these results, DISTs and associated HOSPs were clustered to form a three tier hierarchical configuration of service areas. These successive geographic aggregations, including: 1) 100 DISTs and HOSP clusters; 2) six REGIONAL and HOSP clusters; and 3) two REFERRAL AREAs and HOSP clusters, provide the basis in this study to compare patient flows from different geographic perspectives. To relate these geographic variations to differences in levels of care available, HOSPs and DISTs were both classified into three groups based on the ecology approach. These aggregations of HOSPs and DISTs, first by geographic affiliation and second by levels of care, provided the basis for incorporating the two dimensions of geography and levels of care in deriving patient origin-destination matrix analyses of utilization rates. These matrix analyses are discussed in the following chapter.

CHAPTER IV

DEVELOPMENT OF LEVELS OF CARE BED UTILIZATION PROFILES

In the preceding chapter a framework was developed for assessing geographic variations in the movement of patients seeking hospital care. Various researchers have studied the relationship between patient utilizations and levels of services provided by hospitals (e.g., Elainmy, 1969; Morril & Earickson, 1968; Mountin et al., 1945; Sharp & McCarthy, 1971), implicitly assuming homogeneity of bed utilization by levels of care. These researchers used the hospital as the unit of analysis, rather than assessing variations in the use of beds across hospitals. With the exception of the research by Anderson and Wertz (1977), the investigator was unable to locate studies which employed, either directly or indirectly, the concept of bed utilization profiles as the basis for measuring utilization patterns of hospitals by levels of care, which is the major thrust of this study. In order to investigate the utility of this concept, an initial attempt was undertaken to estimate empirically bed utilization by levels of care profiles (BULPs) for Alberta Hospitals. In this chapter, the developmental process is described under four headings: 1) description of the BULP concept; 2) derivation of provincial utilization rates by levels of care; 3) estimation of the BULPs; and 4) summary.

4.1 The BULP Concept

A BULP is a three element vector which specifies the number (or proportion of beds in each hospital associated with the provision of three levels of inpatient care, primary, secondary, and tertiary. BULPs are unknown population parameters, and as such, these parameters must be estimated from empirical data under certain assumptions which are dependent on models of reality as perceived by the researcher.

In order to explore the BULP concept, two sets of hospital specific BULPs were developed in this study, based on two different models of reality (designated as Models A and B). Basic to both models were two fundamental assumptions regarding the concept of distance minimization. These assumptions were: 1) that patients would access HOSP(s) located within their DIST of origin (assumed to be the closest facility) if the required level of care was available, and 2) if the appropriate level of care was unavailable in the patient's DIST HOSP(s), he/she would then travel (be referred) to the nearest HOSP in another DIST offering the required level of care. Minor deviations from this pattern were expected (e.g., car accidents while travelling); however, it was anticipated that these deviations would balance at the aggregate level and that the effect would be negligible insofar as the entire provincial population was included in the study.

Previous utilization studies have shown that distance minimization was a predominant factor, particularly in rural areas. In view of the fact that Alberta is characterized by: 1) a sparsely distributed rural population, with the exception of a few urban areas which encompass over 50% of the population; 2) a large number of small rural hospitals (less than 100 beds) dispersed throughout the province; 3) extended travel distances between population centres; 4) severe winter climate; and 5) the existence of strong community affiliations in rural areas, it appears logical that patients would use local hospitals and minimize travel times when seeking hospital care. Although previous researchers found that distance minimization was a less predominant characteristic of urban hospital utilization patterns, the fact that the urban populations and associated urban hospitals have been grouped within single geographic areas for this study eliminates this potential source of difficulty.

While there is implicit agreement that levels of care vary across hospitals, the "average" hospital bed has traditionally been the accepted standard for: 1) evaluating hospital operating costs (i.e. costs per bed, per PDAY, per SEP), and 2) assessing the need for regional hospital construction (i.e., beds per capita). With BULPs, the "average" bed is more precisely defined in accordance with existing utilization patterns. Consequently, operating costs associated with different levels of care and the equitable distribution of primary, secondary and tertiary beds can be determined more rationally.

4.2 Development of Models A and B

In accordance with the framework developed in Chapter III, geographic variations in patient flows associated with the classification of HOSPs and DISTs by levels of care were quantified. These patient flows were standardized and then re-analysed using two divergent perceptions about reality (Models A and B); two sets of provincial per capita utilization rates by levels of care were thus derived. The three phases of the development of these models are outlined below:

4.2.1 Analysis of Patient Flows

Two series of patient-origin destination matrix analyses were completed using SEPs and PDAYs. These analyses were designed to: 1) evaluate the suitability of the geographic clusters of HOSPs and DISTs described in Sections 3.3.1 and 3.3.4, and 2) quantify patient flows associated with the three classes of hospitals (A, B, C) and DISTs (X, Y, Z) as conceptualized in Table 4.

Series One. A general assessment of geographic variations in patient-origin destination flows was conducted using several matrix analyses. These matrices were based on different designations of patients' origins and destinations as defined by the three tier configuration of geographic clusters of HOSPs and DISTs. The movements of patients seeking hospital services outside their area of origin (100 DISTs), 6 REGIONs, and 2 REFERRAL AREAs) were measured in PDAYs and SEPs, and the suitability of the three-tier hierarchical configuration of service constituencies was evaluated.

Examination of the movement of patients within (or alternatively outside) their area of origin (Table 5) tends to support the geographic delineation of patient origin-destination movements using the three-level hierarchical configuration of service constituencies (Section 3.3.4). A very small proportion of patients seek hospital care outside their geographic service constituency (Table 5); the outflow decreases as one progresses from the DIST level (21.1% in SEPs) through to the REFERRAL AREA level (1.2% in SEPs). In total 78.9% of SEPs were from HOSPs located within patients' DIST of origin. These results (Table 5) appear to substantiate the validity of the distance minimization assumptions and the use of DIST as the basis geographic unit of analysis. The minimal flow of patients across the boundaries of the REGIONs also tends to confirm that the province can be subdivided into six distinct geographic service regions. Similarly the limited flow of patients between the NRA and SRA (1.23% of the SEPs were hospitalized outside their REFERRAL AREA of origin) indicates that a definite north-south geographic division exists in care-seeking patterns.

TABLE 5

PATIENT FLOWS WITHIN OR OUTSIDE THE BOUNDARIES OF THE HIERARCHICAL CONFIGURATION OF SERVICE CONSTITUENCIES

Geographic Service Constituency		Measure	% of Patient Flows	
Tier	Clusters		Within	Outside
I	100 DISTRICT	SEP	78.9	21.1
		PDAY	77.1	22.9
II	6 REGIONAL	SEP	95.9	4.1
		PDAY	95.1	4.9
III	2 REFERRAL AREAS	SEP	98.8	1.2
		PDAY	98.9	1.1

Note. See hierarchical clustering of geographic areas as presented in Figure 6.

At the DIST and REGIONAL Level, percentage flows of patients outside their area of origin, measured in PDAYs; exceeded the corresponding SEPs values (Table 5). In other words, the ALOS of patients seeking care within their DIST or REGION of origin surpassed that of patients seeking care outside. This trend was most apparent at the DIST level and, as expected, was reversed at the REFERRAL AREA level. These results may be due to the fact that higher level services (i.e., tertiary care) are centralized; therefore, more complex cases requiring longer diagnostic and treatment periods are referred to hospitals outside the patients' service constituency. Consistent with the results shown in Table 5, this trend would be least evident for REFERRAL AREAs which include hospitals providing all three levels of care.

Series Two. The level of care classifications of HOSPs (A, B, C) and DISTs (X, Y, Z) were then superimposed on the data base to derive a second series of patient origin-destination matrices. These analyses illustrated patients' care-seeking movements on a provincial basis by DIST classification (origin) and HOSP classification (destination). Flows within each matrix cell were subdivided to delineate patients seeking care inside and outside their DIST of origin.

The results of these matrix analyses are discussed first in terms of patient flows associated with the Classes of HOSPs and then in relationship to the Classes of DISTs. The 104 Class A HOSPs (providing only primary level care), and the eight Class C HOSPs (providing primary, secondary, and tertiary care) account for almost equal numbers of patient SEPs, for a combined total of 75%, the nine Class B HOSPs provide the remaining 25% of the SEPs (see Table 6). Total PDAYs associated with each Class of HOSP were divided by the corresponding SEPS to

TABLE 6

PATIENT FLOW PATTERNS: DISTRICT CLASS versus HOSPITAL CLASS
(UNIT: 1000 SEPs or PDAYs)

Hospital Class	Measure	Class of District			TOTAL	%
		X	Y	Z		
A	SEP	274.0	5.3	8.2	287.4	36.7
	PDAY	1,847.6	30.1	39.3	1,916.9	31.7
	ALOS[a]	6.7	5.8	4.9	6.7	
B	SEP	39.1	69.5	89.2	197.8	25.3
	PDAY	300.1	474.1	673.8	1,448.8	24.0
	ALOS	7.7	6.8	7.5	7.3	
C	SEP	63.5	5.9	228.3	297.7	38.0
	PDAY	671.8	73.5	1,928.0	2,673.3	44.3
	ALOS	10.6	12.5	8.4	8.9	
Alberta	SEP	376.6	80.6	325.6	782.9	100
	PDAY	2,820.3	577.6	2,641.1	6,039.0	100
	ALOS	7.5	7.2	8.1	7.7	
Percentage	SEPs	48.1	10.3	41.6	100	
	PDAY	46.7	9.6	43.7	100	

[a]ALOS is measured in days.

compare ALOS. A consistent pattern emerged (Table 6) wherein the ALOS increased in direct relationship to the levels of care available in the hospitals (Class A = 6.7 days, B = 7.3 days, C = 8.9 days). These results support the tenet that hospitals providing higher levels of care serve more seriously ill patients who tend to require longer hospital stays for diagnosis and treatment. These results also illustrate that comparisons of hospital resource utilization based on SEPs may be systematically biased across the three classes of HOSPs in terms of the ALOS per SEP. Consequently, it would appear that PDAYs is a more equitable measure of resource utilization than SEPs.

Further analyses revealed that the proportion of residents who obtain hospital services within their DIST of origin increases consistently from Class X (61.4% SEPs or 56.4% PDAYs) through to Class Z (96.7% SEPs or 97.8% PDAYs) (see Table 7). Patients from Classes X and Y DISTs have similar ALOS when hospitalized within their districts of origin; however, the ALOS increases by 1.6 and 2.8 days, respectively, when patients are hospitalized outside of Class X and Y DISTs. Conversely, the ALOS of patients from Class Z DISTs, hospitalized within their DIST of origin, is four days longer than those seeking care outside their DIST (8.2 days versus 4.2 days). If the LOS is a proxy measure of the seriousness of a patient's illness, one could speculate that patients from those DISTs where all levels of care are more readily available (Class Z) tend to be hospitalized for more serious illnesses as compared to patients from Class X and Y DISTs. This phenomenon could be related to several factors including: 1) decreased availability of beds in Class Z DISTs; 2) improved diagnostic capabilities in Class Z DISTs (i.e., increased availability of specialists

TABLE 7

PATIENT FLOWS WITHIN AND OUTSIDE THE BOUNDARIES OF DISTRICT CLASSES AND ALOS[a]

District Classes	Levels of Care Available	Measure	% of Patient Flows	
			Within	Outside
X	I	SEP	61.4	38.6
		PDAY	56.4	43.6
		ALOS	6.9	8.5
Y	I, II	SEP	86.9	13.1
		PDAY	82.4	17.6
		ALOS	6.8	9.6
Z	I, II, III	SEP	96.7	3.3
		PDAY	97.8	2.2
		ALOS	8.2	4.2

[a]ALOS is measured in days.

and diagnostic technologies); 3) a more conservative approach to patient care in more rural areas (Class X and Y DISTs) because of longer travel times and unpredictable weather conditions. Further research in this area is necessary to investigate the impact of these factors on ALOS. Nevertheless, these results strongly suggest the inadequacy of ALOS as a measure of hospital efficiency and/or as the basis for resource allocation when it is used without reference to patients' origins and the levels of care provided by the hospital.

4.2.2 Estimation of Patient Flow Rates

As the next step in the development of Models A and B, inter-class patient flows derived from the aforementioned matrix analyses (Table 8) were standardized in terms of PDAYs per 1000 persons-year. This was accomplished by dividing the patient flows for Class X, Y, and Z DISTs by the respective service populations for these clusters.[4]

The estimates of patient flow rates obtained are presented in Table 9. At the provincial level, the total utilization rate for all levels of care is 1,642.7 PDAYs per 1000 age-sex adjusted persons-year. Of these 375.4 PDAYs per 1000 persons-year (22.9%) are spent in hospitals outside of the patients' DIST of origin. As shown in Table 9, the diminishing tendency for patients to obtain care outside their DIST, as one progresses from Class X through Y to Z DISTs, persists when the flows are standardized: these rates represent 43.6%, 17.6% and 2.2% of the total utilization rates for Classes X, Y, and Z DISTs, respectively. Based on the conceptual framework, this trend coincides with

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[4]The SPs were calculated by summing the age-sex adjusted SP estimates for those DISTs comprising each Class (see Bay et al., 1980, and Raasok 1979, for an explanation of the methodology used).

TABLE 8

INTER-CLASS PATIENT FLOWS IN PDAYs
(Unit: 1000 PDAYs)

FLOW	HOSPITAL CLASS	DISTRICT CLASS X	DISTRICT CLASS Y	DISTRICT CLASS Z	TOTAL
Within District Hospital(s)	A	1,578.0	7.3	0.0	1,585.3
	B	0.0	468.7	669.8	1,138.5
	C	0.0	0.0	1,934.5	1,934.5
	TOTAL	1,578.0	476.0	2,604.3	4,658.3
Outside District Hospital(s)	A	265.7	22.8	43.6	332.1
	B	299.5	5.4	5.5	310.4
	C	655.8	73.5	9.5	738.8
	TOTAL	1,220.9	101.7	58.6	1,381.2
TOTAL	A	1,843.7	30.1	43.5	1,917.3
	B	299.4	474.1	675.3	1,448.8
	C	655.8	73.4	1,944.1	2,673.3
	TOTALS	2,798.9	577.6	2,662.9	6,039.4
Service Population[a]		1,375.7	369.9	1,930.8	3,676.4

[a]Service Population units are in 1000 persons-year. Since the study period extended over 24 months, the provincial population was counted twice. Therefore, the actual study population equals 3,676,400 divided by two. Similarly, the patient flows shown were summed over the 24 month time period.

TABLE 9

INTER-CLASS PATIENT FLOW RATES
(Unit: PDAYs/1000 Persons-year)

FLOW	HOSPITAL CLASS	DISTRICT CLASS			TOTAL
		X	Y	Z	
Within District Hospital(s)	A	1,147.1	19.7	0.0	431.2
	B	0.0	1,267.0	346.9	309.7
	C	0.0	0.0	1,001.9	526.2
	TOTAL	1,147.1	1,286.7	1,348.8	1,127.1
Outside District Hospital(s)	A	193.1	61.7	22.6	90.0
	B	217.7	14.6	2.8	84.4
	C	476.7	198.6	4.9	200.9
	TOTAL	887.5	274.8	30.3	375.4
TOTAL	A	1,340.2	81.3	22.6	521.5
	B	217.7	1,281.6	349.7	394.1
	C	476.7	198.6	1,006.9	727.1
	TOTAL	2,034.6	1,561.5	1,379.2	1,642.7

Note. Because the population increase between 1976 and 1977/78 was not taken into account, utilization rates were somewhat overestimated.

the availability of the three levels of care. Thus, these results appear to corroborate a main premise of this study: geographic variations in patients' care-seeking behaviours follow a logical pattern in relation to the levels of care available in their district of origin.

4.2.3 Estimation of Provincial Utilization Rates by Levels of Care

The estimates of patient flow rates were analysed under two models, which were perceived by the investigator to reasonably approximate reality. Two sets of per capita utilization rates by levels of care were derived. These two models and the associated sets of utilization rates (Models A and B) were based on different assumptions regarding the nature of patient flows.

Model A. Calculation of utilization rates associated with Model A was based on the following four assumptions.

1) Outflows from Class Y DISTs to Class C HOSPs were entirely due to tertiary care (Level III) requirements.

2) Outflows from Class X DISTs were due either to secondary (Level II) or tertiary (Level III) requirements.

3) All primary (Level I) requirements for Class X DISTs' residents were satisfied by Class A HOSPs within those DISTs.

4) Requirements for Level I, II, and III care varied across the three Classes of DISTs. These variations (measured in PDAYs per 1000 persons-year) are directly proportional to the total utilization rate for each Class of DIST and reflect class-specific geographic and climatic considerations. In other words, Level I, II, and III utilization rates include non-medical care requirements that are unique for each Class of DIST. For example, due to the extended travel distances involved and relative lack of specialized support services in rural communities,

physicians in rural areas (X DISTs) are possibly inclined to hospitalize patients in local HOSPs more frequently as compared with physicians in urban centres (Z DISTs) where specialized services are readily available within a few minutes travel time. Similarly, patients from Class X DISTs may be hospitalized for diagnostic tests because of the distance between their residence and the HOSP, while it may be more feasible to diagnose and treat patients from Class Z DISTs on an out-patient basis.

In accordance with these assumptions, Class X, Y, and Z DISTs utilization rates by levels of care for Model A were then determined as follows: 1) total utilization rates for each class were equated with the sum of the flows within and outside DIST HOSPs respectively; 2) basic Level III utilization rates were equated with the outflow of patients from Class Y DISTs seeking care in Class C HOSPs; 3) basic Level I utilization rates were equated with the flow of patients within Class X DISTs seeking care in Class A HOSPs; 4) these basic Level I and III utilization rates were then prorated by the total utilization rate for each Class of DIST; and 5) Class-specific Level II utilization rates were equated with the difference between total utilization rates and the sum of Level I and III utilization rates for each class of DIST. The calculations related to these five steps are presented in Table 10.

Model A utilization rates by levels of care (in PDAYs per 1000 persons-year) and corresponding total PDAYs estimates are summarized in Table 11. For the three levels of care, utilization rates were highest for those DISTs with only Level I services within their boundaries and lowest for those DISTs with three levels of care available. It was

TABLE 10

CALCULATIONS TO DERIVE MODEL A UTILIZATION RATES
(unit: PDAYs/1000 Persons-year)

Step 1: Total Class-Specific Utilization Rates (PDAYs/1000 persons-year).

DIST Class X...R(X) = 2,034.6
Y...R(Y) = 1,561.5
Z...R(Z) = 1,379.2

Step 2: Level III Utilization Rate or R(III)

R(III). . . . R(Y,III) = 198.6 (Assumption 1)

Step 3: Level I Utilization Rates or R(I)

R(I). . . . . R(X,II) + R(X,III) = 217.7 + 476.7 = 694.4 (Assumption 2)
therefore.....R(X,I) = 2034.6-694.4 = 1340.2 (Assumption 3)

Step 4: Prorating R(I) & R(II) by Class Specific Total Utilization Rates

$R(Y,I) \ldots R(Y) \times \frac{R(X,I)}{R(X)} = 1561.5 \times \frac{1340.2}{2034.6} = 1028.6$ (Assumption 4)

$R(Z,I) \ldots R(Z) \times \frac{R(X,I)}{R(X)} = 1379.2 \times \frac{1340.2}{2034.6} = 908.5$ (Assumption 4)

$R(X,III) \ldots R(X) \times \frac{R(Y,III)}{R(Y)} = 2034.6 \times \frac{198.6}{1561.5} = 258.7$ (Assumption 4)

$R(Z,III) \ldots R(Z) \times \frac{R(Y,III)}{R(Y)} = 1379.2 \times \frac{198.6}{1561.5} = 175.4$ (Assumption 4)

Step 5: Level II Utilization Rates or R(II)

R(X,II) = R(X) - R(X,I) - R(X,III) = 2,034.6 - 1,340.2 - 258.7 = 435.7

R(Y,II) = R(Y) - R(Y,I) - R(Y,III) = 1,561.5 - 1,028.6 - 198.6 = 334.5

R(Z,II) = R(Z) - R(Z,I) - R(Z,III) = 1,379.2 - 908.5 - 175.4 = 295.3

Note. Basic utilization rates taken from Table 9.

TABLE 11

LEVELS OF CARE UTILIZATION RATES UNDER MODEL A
(Units: PDAYs/1000 Persons-Year)

DISTRICTS CLASS	S.P.[a]	MODEL A UTILIZATION RATES LEVEL I	LEVEL II	LEVEL III	TOTAL
X	1,375.7	1,340.2 (1,843.7)[b]	435.7 (599.3)	258.7 (355.9)	2,034.6 (2,798.9)
Y	369.9	1,028.6 (380.5)	334.4 (123.7)	198.6 (73.4)	1,561.5 (577.6)
Z	1,930.8	908.5 (1,754.1)	295.3 (570.2)	175.4 (338.6)	1,379.2 (2,662.9)
Alberta	3,676.4	(3,978.3)	(1,293.2)	(767.9)	(6,039.4)
Percentage of PDAYs		(65.9%)	(21.4%)	(12.7%)	(100%)

[a]Service Population estimates are listed in units of 1000 age-sex adjusted persons-year for the 24 month study period.

[b]PDAY estimates in units of 1000 days, corresponding to the utilization rates, are provided in brackets. These estimates were obtained by multiplying the utilization rates by the S.P. estimates for each class of districts and represent Pdays for the 24 month study period.

estimated that in total 2,034.6 PDAYs were used per 1000 persons year by residents of Class X DISTs as compared to a low of 1,379.7 PDAYs per 1000 persons-year by residents of Class Z DISTs (Table 11). Using rates for Z DISTs as a baseline, utilization rates for Y DISTs and X DISTs are approximately 13% and 47% higher, respectively, across all three levels of care. As a percentage of the total PDAYs used in Alberta, Model A utilization rates corresponded to 65.9% for Level I, 21.4% for Level II, and 12.7% for Level III services (Table 11).

Model B. A second set of utilization rates were derived based on the same assumptions (i.e., Assumptions 1-3) as Model A with the following exception. It was assumed that Albertans have similar requirements for secondary and tertiary care, irrespective of their district of origin; therefore, variations in total utilization rates across the Classes of DISTs were related only to disparities in primary care requirements associated with geographic conditions unique to Class X, Y, and Z DISTs (Assumption 5).

Equations were formulated, congruent with these assumptions. The known values were the standardized flows of patients seeking care within and outside their DIST of origin for Classes of DISTs X, Y, and Z. The five unknown values were Level I utilization rates for DIST Classes X, Y, and Z (denoted as R(X,I), R (Y,I), R(Z,I)) and Level II and Level III utilization rates (denoted as R(II), R(III)) which were assumed to be constant across the three Classes. Using the inter-class patient flow rates (Table 9) and the five assumptions, the following equations were formulated:

(1) $R(X,I) + R(II) + R(III) = 2{,}034.6$

(2) $R(Y,I) + R(II) + R(III) = 1{,}561.5$

(3) R(Z,I) + R(II) + R(III) = 1,379.2

(4) R(II) + R(III) = 694.4 Assumption 2 + 5

(5) R(III) = 198.6 Assumption 1 + 5

Equations (1), (2), and (3) were derived from total utilization rates for DIST Classes X, Y, and Z respectively. Equation (4) was based on outflows to Class B and C HOSPs from X DISTs, and equation (5) was based on outflows from Class Y DISTs to Class C HOSPs. By solving these five equations simultaneously, Model B utilization rates by levels of care were estimated (Table 12). In accordance with the assumptions, rates of utilization for Level II (495.8 PDAYs per 1000 persons-year) and Level III (198.6 PDAYs per 1000 persons-year) were constant for the three Classes of DISTs. Differences in total utilization rates were attributable to variations in Level I care requirements. Level I utilization rates ranged from a high of 1,340.2 PDAYs per 1000 personsyear for Class X DISTs to a low of 684.8 PDAYs per 1000 persons-year for Class Z DISTs. Based on Model B utilization rates, total PDAYs in Alberta during the two year study period were designated as: 1) 57.7% Level I care; 2) 30.2% Level II care; and 3) 12.1% Level III care (Table 12).

4.3 Estimation of BULPs

Model A and B estimates of utilization rates by levels of care were applied to the SP of the six REGIONS (GP, ED, CL, RD, LB and MH) in order to compile two sets of bed utilization profiles for the 121 HOSPs in Alberta (BULPs). The following analyses were undertaken in deriving the two sets of BULPs: 1) determination of the SPs for each of the six REGIONS; 2) derivation of the PDAYs generated by the residents of each REGION; 3) allocation of the patient days by levels of

TABLE 12

LEVELS OF CARE UTILIZATION RATES UNDER MODEL B
(Units: PDAYs/1000 Persons-Year)

DISTRICT CLASS	S.P.[a]	MODEL B UTILIZATION RATES LEVEL I	LEVEL II	LEVEL III	TOTAL
X	1,375.7	1,340.2 (1,843.7)[b]	495.8 (682.1)	198.6 (273.1)	2,034.6 (2,798.9)
Y	369.9	867.1 (320.8)	495.8 (183.4)	198.6 (73.4)	1,5[illegible] (577.6)
Z	1,930.8	684.8 (1,322.2)	495.8 (957.4)	198.6 (383.4)	1,379.2 (2,662.9)
Alberta	3,676.4	(3,486.6)	(1,822.9)	(729.9)	(6,039.4)
Percentage of PDAYs		(57.7%)	(30.2%)	(12.1%)	(100%)

[a]Service Population estimates are listed in units of 1000 age-sex adjusted persons-year for the 24 month study period.

[b]PDAY estimates in units of 1000 days, corresponding to the utilization rates, are provided in brackets. These estimates were obtained by multiplying the utilization rates by the S.P. estimates for each class of districts and represent Pday estimates for the 24 month study period.

care to the HOSPs serving the six REGIONs; and 4) conversion of these patient days to comparable hospital bed equivalents.

4.3.1 Determination of Regional Service Populations

Service populations for the six geographic regions were derived by summing the age-sex adjusted SP estimates for those DISTs included within the boundaries of each REGION. The provincial service population of 3,676,400 persons-year was then tabulated by DIST Class of origin within the six REGIONs (see Table 13). The two major urban REGIONs (ED and CL) accounted for 80% of the provincial SP, while the other 20% was distributed across the remaining REGIONs. Proportions of the SPs originating in the three Classes of DISTs varied markedly across the six REGIONs (see Table 13). The subdivisions of the six REGIONAL SPs by Class of DIST were then used in estimating the PDAYs by levels of care.

4.3.2 Estimation of PDAYs by Levels of Care

Estimates of PDAYs by levels of care were calculated by applying Model A and B utilization rates from Section 4.2.3 to REGIONAL Class-specific SPs. Since Level II and III services are, by definition, less readily available within patients' DIST of origin, particular attention was focused on determining PDAYs for Level II and III services for each REGION. These calculations yielded two sets of REGIONAL estimates of PDAYs by levels of care (see Model A - Table 14; Model B - Table 15). For example, according to Table 13, the SP of Grande Prairie consisted of 18.9×10^3 and 51.7×10^3 persons- year for Class X and Class Y DISTs, respectively. Therefore, according to Model A the number of Level II PDAYs required for the X Class DISTs in this REGION are 18.9×10^3 persons x 435.7 per 1000 persons-year = 8.2×10^3 PDAYs. For Y

TABLE 13

REGIONAL DISTRIBUTION OF SERVICE POPULATION BY DISTRICT CLASS
(Unit: 1000 persons-year)

REGION	S.P. BY CLASS OF DISTRICT				%
	X	Y	Z	TOTAL	
Calgary	154.9	0	965.1	1,119.0	30.5
Edmonton	846.3	0	978.5	1,824.8	49.6
Lethbridge	141.1	140.3	0	281.7	7.7
Red Deer	176.6	85.0	0	261.6	7.1
Medicine Hat	24.9	93.0	0	117.9	3.2
Grande Prairie	18.9	51.7	0	70.5	1.9
Alberta	1,362.9	370.0	1,943.6	3,676.4	100%
Percentage	37.1%	10.0%	52.9%	100%	

TABLE 14

COMPOSITION OF REGIONAL PDAYs BY LEVEL OF CARE AND DISTRICT CLASS UNDER MODEL A (Unit: 1000 PDAYs)

REGION	LEVELS OF CARE	DISTRICT CLASSES X	Y	Z	TOTALS
G.P.	I	25.3	53.2	0.0	78.5
	II	8.2	17.3	0.0	25.5
	III	4.9	10.3	0.0	15.2
	TOTAL	38.4	80.8	0.0	119.2
R.D.	I	236.7	87.4	0.0	324.1
	II	76.9	28.4	0.0	105.3
	III	45.7	16.9	0.0	62.6
	TOTAL	359.3	132.7	0.0	492.0
L.B.	I	189.1	144.3	0.0	333.4
	II	61.5	46.9	0.0	108.4
	III	36.5	27.9	0.0	64.4
	TOTAL	287.1	219.1	0.0	506.2
M.H.	I	33.3	95.7	0.0	129.0
	II	10.8	31.1	0.0	41.9
	III	6.4	18.5	0.0	24.9
	TOTAL	50.5	145.3	0.0	195.8
E.D.	I	1,134.2	0.0	889.0	2,023.2
	II	368.7	0.0	289.0	657.7
	III	218.9	0.0	171.6	390.5
	TOTAL	1,721.8	0.0	1,349.6	3,071.4
C.L.	I	207.6	0.0	876.8	1,084.4
	II	67.5	0.0	285.0	352.5
	III	40.1	0.0	169.3	209.4
	TOTAL	315.2	0.0	1,331.1	1,646.3
Alberta	I	1,826.2	380.6	1,765.8	3,972.6
	II	593.6	123.7	574.0	1,291.3
	III	352.5	73.6	340.9	767.0
	TOTAL	2,772.3	577.9	2,680.7	6,030.9

TABLE 15

COMPOSITION OF REGIONAL PDAYs BY LEVEL OF CARE AND DISTRICT CLASS UNDER MODEL B (Unit: 1000 PDAYs)

REGION	LEVELS OF CARE	DISTRICT CLASSES X	Y	Z	TOTALS
G.P.	I	25.3	44.8	0.0	70.1
	II	9.4	25.6	0.0	35.0
	III	3.8	10.3	0.0	14.1
	TOTAL	38.5	80.7	0.0	119.2
R.D.	I	236.7	73.7	0.0	310.4
	II	87.6	42.1	0.0	129.7
	III	35.1	16.9	0.0	52.0
	TOTAL	359.4	132.7	0.0	492.1
L.B.	I	189.1	121.7	0.0	310.8
	II	70.0	69.6	0.0	139.6
	III	28.0	27.9	0.0	55.9
	TOTAL	287.1	219.2	0.0	506.3
M.H.	I	33.4	80.6	0.0	114.0
	II	12.4	46.1	0.0	58.4
	III	5.0	18.5	0.0	23.5
	TOTAL	50.8	145.2	0.0	195.9
E.D.	I	1,134.2	0.0	670.1	1,804.3
	II	419.6	0.0	485.1	904.7
	III	168.1	0.0	194.3	362.4
	TOTAL	1,721.9	0.0	1,349.5	3,071.4
C.L.	I	207.6	0.0	660.9	868.5
	II	76.8	0.0	478.5	555.3
	III	30.8	0.0	191.7	222.5
	TOTAL	315.2	0.0	1,331.1	1,646.3
Alberta	I	1,826.3	320.8	1,331.1	3,478.1
	II	675.8	183.4	963.6	1,822.8
	III	270.8	73.6	386.0	730.4
	TOTAL	2,772.9	577.8	2,680.7	6,031.3

Class DISTs, the number of PDAYs generated for Level II care are 51.7 x 10^3 persons x 334.3 per 1000 persons-year = 17.3 x 10^3 PDAYs (Table 14). Using the same approach, Model B provides 9.3 x 10^3 and 25.6 x 10^3 PDAYs for Level II care for Class X and Y DISTs, respectively, in Grande Prairie REGION (see Table 15).

4.3.3 Allocation of Utilization Estimates to Hospitals

The next stage in the development of the BULPs was to allocate the utilization estimates in PDAYs by levels of care among HOSPs in each of the six REGIONs. To achieve consistency in the distribution of these PDAYs, a series of allocation steps was followed.

PDAY estimates by levels of care for those REGIONS, which are comprised of Class X and Y DISTs and encircle Class A and B HOSPs (i.e., GP, MH, RD & LB REGIONS), were distributed among hospitals as follows:

Step A.1. All Level II PDAY estimates for each REGION were allocated to those Class B HOSPs located within that REGION. For LB REGION, which contains two Class B HOSPs (Municipal and St. Michael's Hospitals), Level II PDAY estimates were allocated in proportion to inflows of patients to these Class B HOSPs from all DISTs comprising the LB REGION (but excluding Lethbridge District where the two hospitals are situated).

Step A.2. Level III PDAY estimates for these four REGIONs were distributed among Class C HOSPs situated in other REGIONs (ED and CL REGIONS). These PDAYs were allocated in proportion to the inflow of patients to these Class C HOSPs from the DIST in which the REGION's Class B HOSP(s) is (are) located.

Step A.3. Level I PDAY estimates for Class B HOSPs in these REGIONs were determined by subtracting Level II PDAY estimates from total PDAYs for the Class B HOSPs. By definition, all PDAYs incurred in Class A HOSPs in these four REGIONs were designated as Level I.

Allocations of Level I, II, and III PDAY estimates for REGIONs encompassing X and Z Classes of DISTs (i.e., ED and CL REGIONs) were confounded by flows of patients seeking three levels of care from Class A, B, and C HOSPs located in these REGIONs. To overcome these complications, the following allocation approach was taken.

<u>Step B.1</u>. Initially, Level II and III PDAY estimates were assigned to Class B and C HOSPs within these REGIONs. These allocations were proportional to the inflows of patients to Class B and C HOSPs in the ED and CL <u>Districts</u>, respectively, from those Class X DISTs within each REGION (excluding those DISTs in which Class B and C HOSPs were situated).

<u>Step B.2</u>. Level III PDAY estimates for ED and CL REGIONs were then allocated separately to Class C HOSPs in these REGIONs (by definition B HOSPs do not provide Level III care). These allocations were in proportion to the inflows of patients to ED and CL REGIONs' Class C HOSPs, respectively, from Class Y DISTs which encompass Class B and possibly Class A HOSPs (GP, RD, LB and MH <u>DISTs</u>). The rational being that since Levels I and II care are available, only residents requiring Level III care would flow out to ED and CL REGIONs.

<u>Step B.3</u>. Subsequently, the allocation of Level II PDAY estimates to Class B and C HOSPs within ED and CL REGIONs was made by subtracting the Level III allocations (determined in Step B.2) from the initial total Level II and III allocations (derived in Step B.1).

<u>Step B.4</u>. Once Level II and III allocation rules were implemented, Level I PDAYs were distributed among HOSPs in these REGIONs. PDAYs

associated with Class A HOSPs were, by definition, designated as Level I. For Class B HOSPs, Level I PDAYs were determined by subtracting Level II PDAY estimates from the total PDAYs for each Class B HOSP. Level I PDAY estimates for Class C HOSPs were obtained by subtracting Level II and III PDAY allocations (derived in Step B.2 and B.3) from total PDAYs associated with each Class C HOSP.

These allocation steps were applied in order to distribute the two sets of regional utilization estimates (Models A & B) in PDAYs by levels of care among Class A, B, and C HOSPs. The resulting PDAYs by levels of care associated with different HOSP are summarized in Table 16.

4.3.4 Delineation of Hospitals' Beds by Levels of Care

The final stage in development of the BULPs was to translate the PDAY estimates derived in the previous section into corresponding proportions (or numbers) of beds for each HOSP. To achieve these estimates, PDAYs by levels of care were converted to a proportion of the total PDAYs for each HOSP and then multiplied by the number of beds in each HOSP. As a result two BULPs, based on Models A and B, were compiled for every HOSP in Alberta.

The two sets of BULPs are listed in Table 17. Of the 11,629 acute care beds in Alberta, 7,821 (67.3%) and 6,957 (59.8%) based on Model A and Model B respectively were designated as providing Level I services. In total, 1,468 (12.6%) using Model A and 1,406 (12.1%) using Model B were identified as Level III beds. The remaining 2,340 beds (20.1%) for Model A and 3,266 beds (28.1%) for Model B were listed as Level II beds. Although, Models A and B were based on different assumptions, similar numbers (or proportions) of beds were designated as Level III.

TABLE 16

HOSPITAL-SPECIFIC UTILIZATION ESTIMATES IN PDAYs BY LEVELS OF CARE UNDER MODELS A AMD B
(unit: 1000 PDAYs)

HOSPITALS				UTILIZATION IN PDAYs BY LEVELS OF CARE					
				MODEL A			MODEL B		
I.D.	NAME	CLASS	TOTAL PDAYS	I	II	III	I	II	III
15	Alberta Children's	C	30.0	1.5	10.3	18.2	0.0	11.8	18.3
16	Foothills Provincial	C	429.3	91.4	150.0	187.8	0.0	241.8	187.5
17	Calgary General	C	486.9	323.1	90.5	73.3	272.3	141.2	73.5
19	Holy Cross	C	309.2	201.3	69.6	38.3	166.4	104.5	38.3
38	Dr. W.W. Cross Cancer	C	39.6	0.0	0.0	39.6	0.0	0.0	39.6
43	Royal Alexandra	C	610.5	379.9	142.0	88.4	335.3	193.6	81.4
44	University of Alberta	C	621.5	111.2	214.8	295.5	18.8	331.6	271.1
303	Charles Camsell	C	146.4	68.5	62.9	14.9	52.7	79.8	13.8
18	Salvation Army Grace	B	68.8	59.2	9.6	0.0	55.5	13.2	0.0
20	Rockyview General	B	107.6	84.2	23.0	0.0	75.3	31.9	0.0
39	Edmonton General	B	331.3	222.3	109.0	0.0	199.3	131.8	0.0
41	Misericordia	B	336.1	203.0	133.1	0.0	175.2	160.9	0.0
56	Grande Prairie Mun.	B	79.6	54.1	25.5	0.0	44.6	35.0	0.0
71	Lethbridge Mun.	B	134.1	77.2	56.9	0.0	60.9	73.2	0.0
72	St. Michael's General	B	115.1	63.3	51.7	0.0	48.6	66.5	0.0
79	Medicine Hat General	B	130.0	88.0	41.9	0.0	71.5	58.4	0.0
92	Red Deer General	B	147.0	41.3	105.3	0.0	17.0	129.7	0.0
	Remaining 104 Hospitals	A	1,917.0	1,917.0	0.0	0.0	1,917.0	0.0	0.0
Alberta			6,039.4	3,986.6	1,296.6	756.1	3,510.7	1,804.9	723.5

Note. These PDAY estimates are based on the 24 month study period.

TABLE 17

BED UTILIZATION BY LEVELS OF CARE PROFILES UNDER MODELS A AND B

HOSPITALS				BED UTILIZATION BY LEVELS OF CARE PROFILES					
				MODEL A			MODEL B		
I.D.	NAME	CLASS	TOTAL BEDS	I	II	III	I	II	III
15	Alberta Children's	C	128	6(5)	44(34)	78(61)	0(0)	50(39)	78(69)
16	Foothills Provincial	C	784	167(21)	274(35)	343(44)	0(0)	441(56)	343(44)
17	Calgary General	C	928	616(66)	173(19)	139(15)	519(56)	269(29)	140(15)
19	Holy Cross	C	532	346(65)	120(23)	66(12)	286(54)	180(34)	66(12)
38	Dr. W.W. Cross Cancer	C	76	0(0)	0(0)	76(100)	0(0)	0(0)	76(100)
43	Royal Alexandra	C	977	608(62)	227(23)	142(15)	537(55)	310(32)	130(13)
44	University of Alberta	C	1,236	221(18)	428(35)	587(47)	39(3)	660(53)	531(44)
303	Charles Camsell	C	365	171(47)	157(43)	37(10)	132(36)	199(55)	34(9)
18	Salvation Army Grace	B	100	86(86)	14(14)	0(0)	81(81)	19(19)	0(0)
20	Rockyview General	B	194	153(79)	41(21)	0(0)	136(70)	58(30)	0(0)
39	Edmonton General	B	559	375(67)	184(33)	0(0)	336(60)	223(40)	0(0)
41	Misericordia	B	555	335(60)	220(40)	0(0)	289(52)	266(48)	0(0)
56	Grande Prairie Mun.	B	130	88(68)	42(32)	0(0)	73(56)	57(44)	0(0)
71	Lethbridge Mun.	B	206	119(58)	87(42)	0(0)	93(45)	113(55)	0(0)
72	St. Michael's General	B	207	114(55)	93(45)	0(0)	87(42)	120(58)	0(0)
79	Medicine Hat General	B	237	161(68)	76(32)	0(0)	130(55)	107(45)	0(0)
92	Red Deer General	B	223	63(28)	160(72)	0(0)	26(12)	197(88)	0(0)
	Remaining 104 Hospitals	A	4,192	4,192(100)	0(0)	0(0)	4,192(100)	0(0)	0(0)
Alberta			11,629	7,821 (67.3)	2,340 (20.1)	1,468 (12.6)	6,956 (59.8)	3,269 (28.1)	1,404 (12.1)

Note. The BULPs measures are presented as: 1) actual bed numbers, and 2) corresponding proportions (in brackets).

The differences were associated with the allocation between Levels I and II. In Chapter V the utility of Model A and B BULPs is evaluated.

Upon reviewing Table 17, four atypical BULPs are in evidence (Model A - Dr. W.W. Cross Cancer Hospital; Model B - Alberta Children's, Foothills Provincial, and Dr. W.W. Cross Cancer Hospitals). Based on the BULPs derived, it appears that these hospitals do not provide Level I and/or Level II care. The Dr. W.W. Cross shows a consistent pattern between Models A and B (i.e., no beds designated to Levels I and II). This may be due to the fact that the Dr. W.W. Cross Cancer Hospital serves only as a referral hospital for a diagnostic - specific group of diseases. The Alberta Children's and Foothills Provincial Hospitals differ between Models A and B BULPs in that, using Model A, both hospitals have Level I beds; while these hospital have only Level II and III beds under Model B. These hospital are also considered to be tertiary referral centres. However, these inconsistencies across the two models are not readily explained.

4.4 Summary

Based on the conceptual framework developed in Chapter III, patient origin-destination utilization patterns were analysed and results were used to derive two sets of BULPs for the 121 HOSPs in Alberta. As part of this developmental process, the appropriateness of the geographic units of analysis selected for this study was evaluated, and two sets of provincial utilization rates for primary, secondary, and tertiary hospital services (Models A and B) were determined. The development of the BULPs represents an initial attempt to use geographic variations in patient utilization patterns to determine the number or proportion of beds in each hospital used for the different levels of care.

The major findings associated with the development of these BULPs, are listed below.

1) Movements of patients within Alberta tend to conform to the three-tier hierarchical configuration of service constituencies (DISTs, REGIONs, REFERRAL AREAs) which were used as the geographic units of analysis in this study.

2) The tendency for patients to minimize distance when seeking hospital services was substantiated with 78.75% of all patient SEPs associated with HOSPs located within patients' DIST of origin.

3) The ALOS of patients seeking care outside their DIST of origin surpassed that of patients seeking care within their area of DIST except for the two urban districts (ED and CL).

4) The ALOS of patients in different Classes of HOSPs increased directly with the levels of care available. These results tend to support the assumption that HOSPs providing higher levels of service (based on the conceptual framework) serve more seriously ill patients who require a different array of services. These results also indicate that comparisons of hospital utilization based on SEPs may be systematically biased across the three Classes of HOSPs in terms of ALOS.

5) Patients originating from DISTs with lower level services have shorter ALOS within their DIST HOSPs, but high total rates of utilization in PDAYs per 1000 persons-year, as compared with patients from DISTs with higher levels of care available (Table 7 & 9). If LOS is deemed to be a reflection of the seriousness of a patient's illness, it would appear that patients from DISTs where higher levels of care are more readily available tend to be hospitalized for more serious illnesses, possibly due to the application of more stringent admission cri-

teria in urban areas. Thus, it would appear that patients' care-seeking behaviours follow a distinct pattern in relationship to the levels of care available in their DIST of origin.

6) Although different assumptions were used, Models A and B produced remarkably similar results, with the exception of a number of specific hospitals. Furthermore, the results appear to confirm the author's general perception regarding levels of care based on size, location, teaching status, or specialization of hospitals.

CHAPTER V

AN EVALUATION OF BED UTILIZATION BY LEVELS OF CARE PROFILES (BULPs)

In Chapter V, the utility of BULP measures developed in the previous chapters is evaluated in terms of the allocation and consumption of resources commensurate with the level of service provided. The BULP methodology could also be of value in assessing utilization patterns associated with a particular region, service population (e.g., paediatrics, geriatrics) or hospital, and in planning the equitable allocation of beds. In an initial attempt to explore these potential applications of BULPs, a series of multiple regression analyses was undertaken. These analyses were intended to ascertain the relative utility of Model A or Model B BULPs (either as raw bed numbers or as percentage equivalents) in explaining interhospital operating cost variations. The documented positive relationship between hospital operating costs and case-mix complexity (e.g., Lave & Lave, 1970; Evans & Walker, 1972; Watts & Klastorin, 1980) provided a basis for this evaluation. In this regard, Model A and Model B BULPs were designated as proxy measures of interhospital differences in the complexity of patients treated.

5.1 Strategy for the Evaluation

Evaluation of the BULPs was a secondary focus undertaken in support of the central purpose in this exploratory study; that is, the development of a methodology to designate hospital beds by levels of care in accordance with geographic variations in hospital utilization patterns. Empirical validation based on objective data is essential in establishing the utility of any new methodology. The initial phase in evaluating the BULPs consisted of an investigation of the association between various measures of hospitals' operating costs and BULPs. A more indepth assessment of the BULP concept, and the methodology developed in this study, could involve "expert" assessment of the results based on a concensus-reaching method such as the Delphi technique (Linstone & Turoff, 1975) or more extensive analysis using econometic models. This type of assessment was, however, considered to be beyond the scope of this study. Given the limitations of this study, only a preliminary evaluation was undertaken. Further evaluation of this methodology is necessary to ensure acceptance by professionals and policy-makers and to establish a basis for the extension of this research.

5.2 Hospital Operating Costs

Various hospital operating cost statistics formed the data base for evaluating the BULPs. A description of these data and the distribution of costs across hospitals in Alberta is presented in the following sections.

5.2.1 Hospital Financial Data

Financial data for 120 Alberta HOSPs[5] were abstracted from the Annual Return of Health Facilities - Hospitals Part One (Annual Returns) for the fiscal years ending March 31, 1978 and 1979. These data are submitted annually, by each HOSP, to AHMC for administrative and statistical purposes.

Several limitations were associated with these data: 1) hospital operating costs are tabulated by types of expenditures (e.g., salary costs, drug costs, medical and surgical supplies, employee benefits), and 2) by major departments/services (i.e., Nursing, Diagnostic and

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[5]Financial data for one 50 bed hospital were not available. Therefore, only 120 of the 121 HOSPs were considered in these analyses.

and Therapeutic, Special Research, Educational Programs, Administrative and Supportive Services). Costs for specific services (or programs) such as intensive care or cardiovascular surgery are not isolated. Also, these data include outpatient costs which may distort, minimally, the nature of the cost relationships insofar as the impact of outpatient utilization was not considered in other aspects of this research design. While it would have been preferrable to have more detailed data so that the cost of individual service units and the impact of outpatient activity could be determined, such specific data were unavailable. The reliability and validity of these data are dependent upon adherence to the established reporting criteria by the various hospitals' personnel.

Two other aspects of these financial data should be noted: 1) the AHMC financial year end was modified in 1977 resulting in a 15 month recording period (January 1, 1977 to March 31, 1978), and 2) the year end for the financial data (March 31) did not coincide with the year end for the PAS utilization data (December 31). To account for the extended recording period, 1977-78 operating costs were prorated. Regarding the PAS data, it was anticipated that a three month difference in year ends would not have an appreciable effect on the results of this study as it represents only a three month time lag on two years of data.

5.2.2 Distribution of Operating Costs

During the 24 month study period there were 781,128 SEP (5,828,101 PDAYs)[6] associated with the 11,579 hospital beds available in Alberta

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[6]SEPs and PDAYs used in the financial analyses were obtained from the Annual Returns. Due to minor differences in the compilation criteria, the PDAY and SEP estimates reported in the Annual Returns and those compiled from the PAS Abstracts for the same recording period differ slightly.

Operating costs in the corresponding 120 HOSPs totalled approximately $834 million. On a province-wide basis, the average operating costs were $36,000 per bed-year, $1,067 per SEP or $143 per PDAY. As illustrated in Table 18, three major hospital departments incurred 95.8% of the operating costs (i.e., Diagnostic and Therapeutics, 21.0%; Nursing, 35.1%; Administration and Support Services, 39.7%). Expenditures on Research and Education were limited to two and 16 hospitals respectively, indicating the restricted applicability of these departmental cost categories as currently defined and/or the limited funding of research and education activities in hospitals in Alberta.

Substantive variations exist among these hospitals in terms of the number of beds, total operating costs, and other unit costs per hospital (Table 19). Particularly noteworthy were disparities in costs per PDAY and costs per SEP which ranged from a low of $360.62 per SEP ($72.77 per PDAY) to a high of $4,458.31 per SEP ($467.76 per PDAY). It would seem reasonable to speculate that these cost variations could be associated with differences in the level of care provided.

5.3 Regression Models

A series of multiple regression analyses was completed in order to evaluate and compare the BULPs; these analyses were based on different sets of dependent (cost measures) and independent variables (bed measures). The resulting regression values were used in assessing the utility of Model A and B BULPs in explaining interhospital variations in operating costs.

5.3.1 Dependent Variables

Three different sets of dependent variables (operating cost measures) were used: 1) total operating costs; 2) average costs per

TABLE 18

HOSPITAL OPERATING COSTS IN ALBERTA BY MAJOR DEPARTMENTS FOR THE STUDY PERIOD APRIL 1, 1977 - MARCH 31, 1979 (n = 120)

Major Departments	Total ($1,000)	Operating Cost Measures[a] Costs/ Bed-Year ($1,000)	Costs /SEP ($)	Costs /PDAY ($)	Per-Centage (%)
Nursing	292,954.4	12.6	375.04	50.27	35.1
Diagnostic & Therapeutic	175,415.8	7.6	224.57	30.10	21.0
Administration & Support Services	330,687.3	14.3	423.33	56.74	39.7
Education	32,021.4	1.4	40.99	5.49	3.8
Research	2,550.0	0.1	3.26	.43	0.3
Alberta	833,629.9	36.0	1,067.28	143.03	100.0

Note. Data were derived from the Annual Return of Health Care Facilities - Hospitals Part I for fiscal years ending March 31, 1978 and 1979.

[a]Numbers of SEPs (781,128) and PDAYs (5,828,101) were obtained from the Annual Returns. Due to minor differences in compilation criteria, estimates of SEPs or PDAYs vary slightly between those reported in the Annual Returns and the PAS separation abstracts.

TABLE 19

DISTRIBUTION OF THE NUMBER OF BEDS, SEPARATIONS, PATIENT DAYS, AND OPERATING COSTS
(n = 120)

Measure	Minimum	Maximum	Mean	Range
Beds/year	8	1,236	96.5	1,228
Total Costs/ year ($1,000)	169.1	59,447.0	3,474.7	59,277.8
SEPs/year	91	40,304	3,255	40,213
PDAYs/year	1,666	365,008	24,283	313,342
Costs/SEP ($)	360.62	4,458.31	914.85	4,097.69
Costs/PDAY ($)	72.77	467.76	119.55	394.99

Note. These data were collected over a 24 month time frame. Thus, the measures listed represent average values per year, per SEP, or per Pday based on the 24 month period.

PDAY; and 3) average costs per SEP. In addition, these three primary cost measures were subdivided by major departmental groupings (i.e., Nursing (NSG), Diagnostic/Therapeutic (DIAG), and Administration/ Support Services (ADM)) as a means of exploring, in more detail, the association between the BULPs and operating costs[7]. As listed below, a total of 12 different cost measures (3 sets) were used as dependent variables.

Dependent Variables Sets

TOTAL COSTs	Average COSTs Per SEP	Average COSTs Per PDAY
TOTAL	TOTAL/SEP	TOTAL/PDAY
NSG	NSG/SEP	NSG/PDAY
DIAG	DIAG/SEP	DIAG/PDAY
ADM	ADM/SEP	ADM/PDAY

5.3.2 Independent Variables

The following five sets of bed measures were designated as independent variables.

Independent Variable Sets

1) Total numbers of rates beds in each hospital as a proxy measure of hospital size (BEDS).
2) Total numbers of rated beds by three levels of care, BEDA1, BEDA2, BEDA3, based on Model A (BEDA).
3) Total numbers of rated beds by three levels of care, BEDB1, BEDB2, BEDB3, based on Model B (BEDB).

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[7]Cost breakdowns for Research and Education were not attempted because this information was not available for many hospitals from the Annual Returns.

4) Proportional estimates of beds by three levels of care, PA1, PA2, PA3, derived from Model A (PA).

5) Proportional estimates of beds by three levels of care, PB1, PB2, PB3, derived from Model B (PB).

These different sets of independent variables were used to compare the usefulness of BULPs in explaining the variation in cost behaviours across hospitals.

5.3.3 Specification of the Regression Analyses

Three series of regression analyses (Specifications I, II, and III) were undertaken based on various combinations of these sets of dependent and independent variables.

Specification I. Traditionally hospital costs have been investigated using the number of beds as the independent variable, because this approximates hospital size. This approach provides an estimate of marginal cost per bed. The difficulty with this approach is that it is based on the implicit assumption that hospital beds are more or less equivalent vis à vis the levels of care provided; the major focus of this study was to challenge this implicit assumption by developing a methodology (BULPs) which differentiates among hospital beds by levels of care. Thus, BEDS was used to establish a baseline for comparing the results from the four remaining independent variable sets which are based on the BULP concept. The regression model used was:

$$y = \beta_0 + \beta_1 X + E \qquad (1)$$

where Y represents the dependent variable and assumes the value of TOTAL, NSG, DIAG, or ADM cost measures and X represents the independent bed measure, BEDS.

Specification II. The second series of specifications used TOTAL COSTs as the dependent variable set and Model A or Model B BULP measures expressed in numbers of beds as the independent variable sets; such that:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + E \qquad (2)$$

where

y assumes the value of TOTAL, NSG, DIAG, or ADM.

X_1 represents the number of beds in Level I (BEDA1 or BEDB1)

X_2 represents the number of beds in Level II (BEDA2 or BEDB2)

X_3 represents the number of beds in Level III (BEDA3 or BEDB3)

From these analyses, it was possible to compare the relative explanatory value of BULPs under Model A or B, as well as determining the marginal costs associated with changes in bed number for each level of care (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975).

Specification III. Some limitations were associated with Specifications I and II in that extreme variability in the size of hospitals (i.e. 8 beds to 1236 beds) and total cost measures (i.e., $169,149 to $59,277,810) appeared to overshadow the potential association between costs and levels of care. In order to control for the dominant influence of hospital size, it was determined that unit costs (costs per SEP or PDAY) rather than total costs would be more meaningful. However, other researchers have regressed unit costs on BEDs without obtaining a good fit (e.g., Wallace, 1975), thus suggesting that hospital size measured in BEDs may not be adequate to explain the variability of unit costs and possible interaction of case-mix differences (or the levels of care provided). In order to investigate the association between BULPs and unit costs, it appeared necessary to remove the influence of hospital size from the BULP measures. This was achieved by using the percentage form of the BULPs (in lieu of the actual bed numbers); as such, the PA and PB independent variable sets were employed instead of BEDA and BEDB. One difficulty inherent in the use of these percentage variable sets is that, by definition, the three elements of each hospital specific BULP sum to 100. Consequently, when regression analyses were conducted using the standard regression model with a constant term, linear dependency problems arose between the three components of the independent variable sets, PA or PB (percentages of beds in the three levels of care), and the implicit independent variable associated with the constant term. In other words, only three of the four parameters could be estimated under these conditions. To resolve these multicolinarity problems, a linear regression model without a constant term (see Biomedical Computer Programs, Dixon, 1975) was used, such that

$$Y = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + E \qquad (3)$$

where

Y assumes unit costs expressed either per SEP or per PDAY (TOTAL/SEP, NSG/SEP, DIAG/SEP, ADM/SEP or TOTAL/PDAY, NSG/PDAY, DIAG/PDAY, ADM/PDAY);

X_1 represents the percentage of Level I beds;

X_2 represents the percentage of Level II beds;

X_3 represents the percentage of Level III beds.

Further modification of this specification was necessary because the computer program available for this analysis (Dixon, 1975) estimates multiple correlation using equation (3) above against the restricted equation with $\beta_1 = \beta_2 = \beta_3 = 0$, where it would be more appropriate to use $\beta_1 = \beta_2 = \beta_3$. To achieve this more correct form, the dependent variables were converted to the corresponding deviation scores (i.e., the unweighted mean value was subtracted from each set of dependent variables).[8] In addition, standard regression analyses using the unit cost measures (costs/SEP & costs/PDAY) and the independent variable, BEDS, were run. The results of these analyses provide a baseline for assessing Specification III results where the hospital size factor is removed from the BULP measures (PA & PB independent variable sets).

5.4 Regression Analyses - Results and Discussion

Results of the regression analyses, based on the three sets of specifications, are discussed according to their usefulness in explaining operating cost variations among HOSPs measured in TOTAL COSTs, COSTs per SEP, and COSTs per PDAY.

5.4.1 TOTAL COSTs and BEDs

The results of the regression analyses under Specification I are presented in Table 20. As expected the R square values were very high (0.90 $\approx$ 0.99) suggesting a good fit of the regression equation when BEDs is used as the independent variable. Nonetheless, as noted previously, those results are not surprising given the extreme variations in hospital size (bed numbers) and associated total costs. The marginal costs per bed were estimated at \$43,920, \$15,300, \$10,400, and

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[8]Without this adjustment, the Biomedical Computer Programs (Dixon, 1975) produces R square values which are overly high because the sum of the squares is evaluated from the origin, rather than from the mean.

\$14,990 per bed-year for TOTAL, NSG, DIAG, and ADM, respectively[9].

5.4.2 TOTAL COSTs and BULPs

The results of regression analyses under Specification II are also reported in Table 20. The range of the R squares is 0.96 ≈ 0.99 indicating that there was a good fit for the regression equations. It is noteworthy that there were minimal differences between Model A and B BULPs, expressed as actual bed numbers (BEDA and BEDB), in terms of explaining interhospital variations in total costs: when rounded to two decimal places the R square values were the same. It is conceivable, however, that the extreme variation in hospital bed numbers and total costs may have dominated to such a degree that differences due to Model A or Model B BULPs were obscured. From these analyses, marginal costs per bed-year based on Model A were \$34,600, \$41,500, and \$61,200 for Level I, II, and III beds, respectively; corresponding costs for Model B were \$34,900, \$39,000, and \$63,000. These results indicate remarkable agreement between the two Models. The marginal costs for the major departments (Table 20) were relatively uniform among the three levels of beds with the notable exception of DIAG costs for Level III beds: the marginal DIAG costs related to Level III beds were approximately three times larger than those for Level I or II beds under Models A and B. These results indicate that substantially greater diagnostic and therapeutic costs are associated with HOSPs

[9]The dependent cost measure TOTAL is the sum of the costs for NSG, DIAG, ADM, as well as Research and Education; the analyses were carried out independently. Therefore, the cost per bed estimates calculated from the regression analyses based on NSG, DIAG, and ADM do not sum to the cost estimates obtained from the regression analyses using TOTAL costs.

TABLE 20

RESULTS OF REGRESSION ANALYSES INVOLVING TOTAL HOSPITAL OPERATING COSTS
(n = 120)

Independent Variable Set	TOTAL Costs	TOTAL COSTs by Major Department		
		NSG	DIAG	ADM
BEDS				
Reg. Coeff.[a]	43.92	15.30	10.40	14.99
Constant[a]	-1,528.57	-510.88	-547.16	-137.24
R Square	0.97	0.99	0.90	0.98
BEDA				
Reg. Coeff.				
BEDA1	34.55	15.03	6.96	13.78
BEDA2	41.48	14.06	6.66	17.46
BEDA3	61.17	17.13	20.03	14.04
Constant	-641.85	-472.76	-189.05	-53.34
R Square	0.99	0.99	0.96	0.98
BEDB				
Reg. Coeff.				
BEDB1	34.90	15.03	7.23	14.00
BEDB2	38.95	14.34	6.97	16.09
BEDB3	62.95	17.29	21.88	14.17
Constant	-665.66	-474.66	-207.68	-63.79
R Square	0.99	0.99	0.96	0.98

[a]The regression coefficients and constant values are expressed in $1,000 units.

which provide Level III care. It would appear that the marginal cost information provided in Table 20 could be very useful for hospitals in forecasting budget requirements arising from changes in programs which may alter the utilization patterns associated with their beds.

5.4.3 COSTs per SEP and BULPs

The results of the regression analyses based on Specification III and costs per SEP are given in Table 21. It is observed that the R square value ranged from 0.08≈0.87, suggesting that the relationship between BULP measures and unit measures of hospital operating costs (as quantified by the R square values) varies significantly depending on the cost centre involved. There is modest association between BULPs and TOTAL/SEP costs as evidenced by an R square value of 0.56 for both Models A and B. Further analyses by major departments indicates that BULPs have: 1) a minimal association with NSG (R square 0.08); 2) very high association with DIAG (R square 0.86≈0.87); and 3) a modest association with ADM (R square 0.21). Notably, Models A and B yielded almost identical R square values when rounded to two decimal places. In comparison, BEDS explained minimal interhospital cost variations with R square values ranging from 0.05≈0.07. The poor performance of BEDS in accounting for variations in costs per SEP is congruent with the results of other studies (e.g., Schumacher & Horn, 1979; Watts & Klastorin, 1980). Costs per SEP incorporate the effects of LOS and hospital occupancy rates. Consequently, the influence of hospital size (in beds) is minimized and instead the efficient use of beds (productivity) is emphasized.

The regression coefficients for PA and PB reveal interesting and generally similar marginal cost patterns. Unlike the results under

TABLE 21

RESULTS OF REGRESSION ANALYSES INVOLVING HOSPITAL OPERATING COSTS PER SEP
(n = 120)

Independent Variable Set	TOTAL Costs/SEP	Costs/SEP by Major Department NSG	DIAG	ADM
Unweighted Mean[a]	914.85	326.92	144.33	434.41
PA[b]				
Reg. Coeff.[a]				
PA1	-0.85	-0.14	-0.47	-0.16
PA2	-1.27	1.23	-0.22	-2.18
PA3	33.61	2.76	17.64	9.86
R Square	0.56	0.08	0.86	0.21
PB[b]				
Reg. Coeff.				
PA1	-0.83	-0.14	-0.45	-0.15
PA2	-1.52	1.02	-0.61	-1.91
PA3	34.23	2.66	18.04	10.16
R Square	0.56	0.08	0.87	0.21
BEDS[c]				
Constant[a]	849.00	307.34	115.91	428.07
Reg. Coeff.[a]	0.34	0.10	0.15	.03
R Square	0.05	0.07	0.06	.00

[a]Regression coefficients and unweighted means are expressed in dollars ($).

[b]The analyses were conducted using dependent variables in the form of deviations from unweighted means.

[c]These analyses were conducted using standard regression format and BEDS as the independent variable, for comparative purposes.

Specification II, ADM costs together with DIAG costs contribute significantly to the difference in costs per SEP between Level II and III: the corresponding marginal ADM and DIAG costs are approximately $10.00 and $18.00 per SEP under both Model A and B (Table 21). With the exception of NSG, where the marginal costs increase gradually across the three levels of beds, marginal costs for the other cost centres (i.e., TOTAL, DIAG, ADM) are generally slightly lower for PA2 (or PB2) beds as compared with PA1 (or PB1) beds, and then increase significantly for PA3 (or PB3) beds. For example, if 1% of the total beds formerly used to provide Level I care was converted to Level III care, $34.46 or $35.06 would be added to the TOTAL costs/SEP using Model A or B, respectively. These results may illustrate economies of scale with respect to basic administrative/support services (e.g., medical records, laundry, dietary, central supply, maintenance, general administrative staff, materiel management) and diagnostic/therapeutic services (e.g., laboratory, pharmacy, radiology, social work, rehabilitation medicine) that are required to run a hospital of any size. Once a primary care hospital is operational, the addition of beds to provide secondary level care would not necessarily increase total costs per SEP. As such, increased costs may be offset by more efficient use of ADM and DIAG services (economies of scale). The very high regression coefficient values for Level III ADM may be indicative of the high costs associated with the large numbers of technical and administrative staff required to operate the more sophisticated services where tertiary care patients are treated. Due to the small number of patients using these very specialized services, it could be hypothesized that optimal economies of scale may not yet exist in the provision of tertiary level services in Alberta. This theorization is supported by the results of Finkler (1979b), who found that economies of production for large hospitals are offset by the failure to achieve economies of scale on specialized tertiary services, such as cardiac surgery.

5.4.4 COSTs per PDAY and BULPs

Results of the regression analyses, based on COSTs per PDAY and Specification III, parallel many of the results noted in the preceding section. The R square values ranged from $0.19 \approx 0.80$, exhibiting similar results as those obtained in the preceding section using COSTs per SEP measures (Table 22). Model A and B produced comparable results in terms of R square values and regression coefficients. Corresponding R square values using BEDS were significantly less effective in explaining interhospital variations in costs (R square values ranged from $0.00 \approx 0.12$).

The regression coefficients for PA and PB variable sets followed the same patterns as in Section 5.4.3 with one exception: marginal NSG costs per PDAY values were lowest for Level I, peaked for Level II, and dropped to a medium value for Level III. Although the R square values for NSG costs per PDAY ($0.19 \approx 0.20$) were slightly higher, as compared to using costs per SEP, the marginal cost results and R square values, in comparison to other cost relationships using BULPs expressed in percentages, could not be explained within the context of this study. These unexpected results warrant further investigation.

5.4.5 Summary

Results of these regression analyses lend support to the conceptual basis of this study, that utilization patterns are linked to the

TABLE 22

RESULTS OF REGRESSION ANALYSES INVOLVING
HOSPITAL OPERATING COSTS PER PDAY
(n = 120)

Independent Variable Set	TOTAL Costs/SEP	Costs/SEP by Major Department		
		NSG	DIAG	ADM
Unweighted Mean[a]	119.55	42.81	18.94	56.80
PA[b]				
Reg. Coeff.[a]				
PA1	-0.10	-0.02	-0.06	-0.02
PA2	0.25	0.27	-0.09	-0.11
PA3	3.29	0.16	1.88	0.91
R Square[a]	0.62	0.19	0.79	0.20
PB[b]				
Reg. Coeff.				
PA1	-0.10	-0.02	-0.05	-0.02
PA2	0.09	0.21	0.01	-0.12
PA3	3.38	0.15	1.94	0.95
R Square	0.63	0.20	0.80	0.21
BEDS[c]				
Constant	113.26	40.90	15.98	56.58
Reg. Coeff.	0.03	0.01	0.02	0.00
R Square	0.05	0.12	0.05	0.00

[a]Regression coefficients and unweighted means are expressed in dollars ($).

[b]The analyses were carried out using dependent variables in the form of deviations from the unweighted means.

[c]These analyses were conducted using the standard regression format and BEDS as the independent variable, for comparative purposes.

requirements for different levels of care, which in turn are associated with variations in the operating costs of hospitals providing different levels of care. Model A and B BULPs, expressed in actual bed numbers or percentages, yielded similar R square values (ranging between 0.08 ≈ 0.99) in explaining interhospital cost variations (measured as TOTAL COSTs, COSTs per SEP, or COSTs per PDAY). Using either Model A or B BULPs, only minor cost variations were apparent between Level I and Level II beds; however, a dramatic increase in costs was associated with Level III beds. The highest proportion of the increments in costs for Level III beds was related to large increases in costs for DIAG services and moderate increases for ADM. In contrast, no consistent pattern of costs for NSG was evident. From this, one could speculate that the allocation of nursing resources does not reflect the complexity of the case-mix in provincial hospitals.

5.5 Hospital Operating Costs by Levels of Care

The preceding analyses provided a basis for projecting hospital operating costs in terms of TOTAL COSTs, COSTs per SEP, or COST per PDAY. The calculation of these estimates is based on the standard linear equation:

$$Y = C + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + E$$

where Y is the projected value of the dependent variable (i.e., TOTAL COSTs, COSTs per SEP, COSTs per PDAY); C is the intercept term or constant which is added to each case; X_1, X_2, X_3 are the independent variables; β_1 is a regression coefficient and represents the expected change in Y, with a change of one unit in X_1, when X_2 and X_3 are held constant (the same explanation holds for β_2 and β_3); and E is the error or the difference between the actual and the projected value of Y for each case.

Projected operating costs for each hospital can be calculated using Model A and B BULPs or BEDs variable sets. The basic equations for these variable sets are illustrated below. (As noted in Section 5.3.3, the constant term was eliminated when using variable sets based on proportional estimates of Model A and B BULPs).

TOTAL COSTs Per Hospital ($1,000 units)

Using the results noted in Table 20, TOTAL COSTs per hospital can be projected based on following equations.

BED $Y = -1529 + 43.92\ X$

BEDA $Y = -642 + 34.5\ X_1 + 41.48X_2 + 61.17X_3$

BEDB $Y = -666 + 34.90\ X_1 + 38.95X_2 + 62.95X_3$

where X_1, X_2 and X_3 equal the number of beds used to provide the three levels of care in each HOSP, and X equals the total number of beds in each of the 120 study HOSPs. According to these equations, using BEDA, a change of one bed from Level II to Level III care would increase the HOSP's operating cost by $19,690 (i.e., [61.17 - 41.48] x $1,000).

TOTAL COSTs Per SEP ($ units)

Using the results provided in Table 21, TOTAL costs per SEP can be determined as follows:

PA $Y = (-0.85)\ X_1 + (-1.27)\ X_2 + (33.61)\ X_3 + 914.85$

PB $Y = (-0.83)\ X_1 + (-1.52)\ X_2 + (34.23)\ X_3 + 914.85$

where X_1, X_2, X_3 equal the proportion of Level I, II, III beds in each HOSP. Using either PA or PB equations, a 1% shift in the proportion of beds in a HOSP used to provide Level III care instead of Level

I care would increase the cost per SEP by $34.46 and $35.06, respectively. (The unweighted mean ($914.85) must be added because these regression analyses were conducted using deviation scores (Y-914.8)).

TOTAL COSTs Per PDAY ($ units)

Total costs per PDAY can be projected using the following equations which are derived from the results presented in Table 22:

PA $Y = (-0.10)\ X_1 + (0.25)\ X_2 + (3.29)\ X_3 + 119.56$

PB $Y = (-0.10)\ X_1 + (0.09)\ X_2 + (3.38)\ X_3 + 119.56$

where X_1, X_2, X_3 equal the percentage of beds in each level of care for a HOSP and the unweighed mean equals 119.56. For PA and PB equations, a 1% shift in beds providing Level III care instead of Level I care would increase average PDAY costs at that HOSP by $3.39 and $3.48, respectively.

These equations can also be calculated based on the costs associated with NSG, DIAG and ADM. Cost implications for each department arising from a change in the allocation or utilization of hospital beds among the three levels of care can be derived using these different variable sets and the regression coefficient values reported in Tables 20, 21, and 22.

5.6 Concluding Summary

In order to evaluate Model A and B BULPs, a series of regression analyses were undertaken using five sets of independent variables (bed measures) and three sets of depend variables (hospital operating cost measures). Four of these bed measures were based on Model A and B BULPs, expressed in actual bed numbers (BEDA & BEDB) and in proportions (PA & PB). The total number of beds in each HOSP (BEDS) formed the fifth independent variable set and was used as a baseline in comparing Model A and B BULPs.

Consistently, BULPs based on Models A and B explained similar amounts of the variation in interhospital operating costs with R square values ranging between 0.08 $\approx$ 0.99. BULPs were superior to BEDS in explaining cost variations when comparisons were made using the same operating cost measures. In this regard, the relative superiority of the BULPs was most apparent when unit measures of operating costs (costs per SEP or PDAY) were employed. With unit costs, BULPs accounted for a large amount of the variation in DIAG costs (R squares 0.79 $\approx$ 0.87), but were less useful in explaining unit cost variations for ADM (R square 0.20 $\approx$ 0.21) and NSG (R square 0.08 $\approx$ 0.20) respectively. One could speculate from these results that, unlike DIAG services, ADM and particularly NSG are not directly related to the level of care provided. This situation could exist for a number of reasons including the possibility that ADM and NSG services are not allocated rationally, or alternatively, that a basic level of ADM and NSG services must be maintained in hospitals which is not necessarily reflective of the level of care provided to patients.

BULPs analyses of unit costs demonstrated similar marginal cost patterns for TOTAL COSTs and cost of the major departments, DIAG and ADM. In general, the associated marginal costs were lower for Level II beds than for Level I beds, and then increased significantly for Level III beds. These unexpected marginal cost results may be related to the impact of economies of scale for hospitals providing Level II services. Inconsistent marginal cost patterns were obtained for NSG.

Overall, the results of these analyses appear to confirm that hospital bed utilization by levels of care has validity in assessing hospital operating costs, except for NSG. Further analysis, possibly using more sophisticated econometric models, is warranted.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In Chapter VI the findings of this study, which was undertaken to derive a methodology for estimating hospital bed utilization by levels of care, are summarized. An overview of the rationale and approach taken in developing the research methodology and the major findings and conclusions arising from this research are presented. Finally, recommendations for additional research on this topic are proposed.

6.1 Summary of the Study

Wherein Alberta ranks above the national average in acute care hospital beds per capita, concerns have been raised that these beds are not equitably distributed across Alberta (Darnell et al., 1977; Hospital Utilization Committee, 1979). As a result, this study was undertaken with the main purpose of developing a methodology, based on patients' actual care-seeking behaviours, from which area-wide and hospital-specific estimates of the number (or percentage) of beds used to provide the three levels of care - primary, secondary, and tertiary - could be derived. A major premise of this study was that hospital beds are not equivalent, insofar as hospitals throughout a large area support different levels of care. It was anticipated that this methodology would be of value to planners, policy initiators, and administrators for ensuring more efficient and effective utilization and allocation of hospital beds.

A selected review of the literature was completed in order to establish a realistic approach for achieving the stated purpose, given the limited resources available. An overview of the theoretical relationships among need, demand, and utilization provided a basis for understanding the complexities involved in determining the need for different levels of acute care hospital services and achieving an equitable distribution of specific health resources. Examination of the major classification methodologies employed in the health care field served to place this study in perspective, to clarify fundamental concepts, and to illustrate the utility of classification approaches. In recognition of the potential utility of classification methodologies in analysing patient utilization patterns, a review of patient origin-destination research was undertaken. By integrating various components from these different aspects of the literature, a conceptual framework and methodology for estimating hospital beds by levels of care was developed.

Congruent with the exploratory nature of the study, the initial phase of the methodology involved the development of an analytic framework for estimating hospital-specific bed utilization by levels of care. This was accomplished by first clustering hospitals and hospital districts to conform with the natural flow patterns of patients, and by then classifying hospitals and hospital districts in accordance with geographic variations in patient utilization patterns. Patient origin-destination data were employed primarily in measuring these variations; these results were then analysed using a regionalization or ecology approach in relating utilization patterns to different classes of hospitals and levels of care.

In the second phase of the methodology, a series of patient origin-destination matrix analyses were conducted, and patient flows associated with the hospital and district classifications identified in the conceptual framework were calculated. These flow rates were then analysed using two divergent models of reality (Models A and B), and two sets of provincial per capita utilization rates for primary, secondary, and tertiary care were estimated. Estimates of utilization rates under Models A and B were applied to the service populations for the six geographic regions comprising the province; two sets of patient days estimates by levels of care were obtained. These patient days were allocated to the hospitals in the province in accordance with observed regional referral patterns. Two sets of bed utilization profiles by levels of care (BULPs) were compiled for the 121 hospitals in Alberta by converting these patient-day estimates by levels of care to the corresponding numbers (or percentages) of beds in each hospital.

In the final phase of this study, an initial evaluation of the methodology for estimating hospital bed utilization by levels of care was completed. Based on the premise that hospital operating costs should be directly related to the complexity of the case-mix treated (or the levels of care provided), the utility of BULPs (under Models A and B) in accounting for variations in hospital operating costs were investigated. A series of regression analyses were completed using various bed measures (independent variables) and cost measures (dependent variables).

Demographic, utilization, and financial information compiled by the Government for administrative purposes formed the data base for this study. As such, an implicit objective of this study was to evaluate the utility of information collected by the Government as a data source for investigating aspects of the health care system.

6.2 Findings and Conclusions

The significant findings arising from this initial attempt to develop a methodology for estimating hospital bed utilization by levels of care are outlined below.

1) Although there is an abundance of literature on the individual topics of: 1) need for health services; 2) allocation of health resources using disease, patient, or hospital classification methodologies; and 3) detailed analyses of differences in utilization patterns based on patient origin-destination data, empirical studies could not be located which related these aspects to a planning framework for determining acute care bed utilization by levels of care. Although the relationship between patient utilization patterns and the provision of acute care services has been thoroughly investigated, the unit of analysis for these studies was usually the hospital, rather than assessing variations in the use of beds across hospitals.

2) Evidence exists that the care-seeking patterns of patients within Alberta tend to conform to the three-tier heirarchical configuration of service constituencies congruent with the regional (or ecological) approach to assessing patient utilization. As such, the 103 hospital districts were hierarchically clustered to form six distinctive geographic service REGIONs and two REFERRAL AREAs. There was a minimal flow of patients (1.29% separations) between the two REFERRAL AREAs indicating that a definite north-south geographic division exits in patient origin-destination flow patterns.

3) Using various measures of geographic variation in the care-seeking patterns of patients, it was possible to classify hospitals and hospital districts into three categories, based on whether or not primary, secondary, or tertiary services were provided by the hospital or available in the district. According to the highest level of care provided or available, there were eight hospitals and two districts designated "tertiary", nine hospitals and four districts designated as "secondary", and 104 hospitals and ninety-four districts designated as "primary".

4) The average length of stay of patients in different Classes of hospitals increased directly with the levels of care available; while, the average length of stay of patients seeking care outside their districts exceeded the average length of stay of patients seeking care within their districts of origin, except for Edmonton and Calgary where all three levels of care were available.

5) Estimates of primary, secondary, and tertiary care utilization rates, expressed as a percentage of total provincial patient days, were respectively: 1) Model A - 66%, 21%, 13%, and 2) Model B - 58%, 30%, [illegible]%.

6) Intra-hospital Class variatons existed in the percentage estimates of beds in each hospital providing a particular level of care. These variations were evident under both Models A and B. The widest variations were for the percentage of tertiary care beds in Class C hospitals. Hospitals with a high percentage of tertiary care beds were those known to be closely affiliated with university medical facilities or hospitals treating special segments of the population or restricted disease entities.

7) Using either Model A or B, total utilization rates for each Class of district increased inversely with the levels of care available.

8) Models A and B BULPs, expressed in actual bed numbers or percentages, yielded similar R square values in explaining inter-hospital cost variations. Using either Model, minimal differences in costs were evident between Level I and II beds; however, a significant cost increase was associated with Level III beds. Large increases in diagnostic and therapeutic costs, and moderate increases in administration and support services costs accounted for this large increment in costs for Level III beds.

The conclusions arising from this study are presented subsequently. Given the limitations inherent in this study, these conclusions should be applied only within the geographic context and time-frame of this research. Since various aspects of hospital utilization in Alberta were not addressed, these conclusions are provisional pending the replication and validation, and/or modification of this methodology by other researchers.

1) There appears to be a natural regionalization process occurring with respect to patients' use of acute care services in Alberta that conforms to the patient's tendency to minimize distance (or travel times) in seeking health care services. This was substantiated by the identification of six distinct REGIONs based on patient origin (hospital district)-destination (hospital) data.

2) The results indicate the presence of two mutually exclusive REFERRAL AREAs, dividing the province approximately in half vis à vis the population, along an east-west boundary.

3) With respect to the research problem, the BULPs methodology appears to have utility for estimating the number (or percentage) of beds in hospitals used to provide primary, secondary, and tertiary care services.

4) It would appear that hospital bed utilization patterns as measured by the BULP methodology are linked to requirements for different levels of care, which in turn are associated with variations in hospital operating costs.

5) Economies of scale appear to be operant in the provision of different levels of care, particularly with respect to secondary levels of care. This was illustrated by the marginal cost differences for diagnostic/therapeutic and administration/support services departments between primary and secondary beds.

6) Using unit cost analyses (costs per separations and per patient day), it would appear that the diagnostic/therapeutic department costs contributed to the major portion of interhospital variations in operating costs using the BULP methodology.

7) Nursing department costs seem to bear no relation to the levels of care provided by hospitals using the BULP methodology.

8) The Government data base for acute care hospitals appears to be useful for analysing utilization patterns and gross costs associated with acute care hospitals.

6.3 Recommendations

The following recommendations are based on an integration of the findings and conclusions of this study.

1) The Government should adopt a regionalization framework, congruent with actual utilization patterns, in assessing hospital bed util-

ization and allocating health care resources for different geographic service populations. Not only would this facilitate a more equitable distribution of resources in line with established care-seeking patterns, but it would also identify, for health care users, a comprehensive network for obtaining required levels of health care. Hopefully, it would also minimize the unnecessary duplication of costly services.

2) Planning guidelines for the provision of acute care beds should be established which incorporate the concept of different levels of care. If it is accepted that provincial utilization rates by levels of care approximate the need for the different levels of care, then regional disparities could be determined against this standard, measured as the number of primary, secondary, and tertiary beds per 1000 age-sex adjusted persons-year.

3) Financial data collection for hospitals should be re-organized to incorporate the tabulation of program-specific data. This would permit a more precise analysis of the cost relationships using the BULP methodology. The isolation of outpatient costs from inpatient costs would also improve the accuracy of cost analysis using the BULP methodology.

4) In order to validate and extend the methodology employed in this study, it is recommended that the following additional research be undertaken: that,

   i studies of the average length of stay of patients from rural versus urban areas, hospitalized for comparable diagnostic and treatment services, be conducted to determine the factors accounting for differences in the average length of stay between these different geographic service populations;

ii the BULP methodology be repeated, using morbidity and/or age-sex specific data; this could provide more detailed information for particular service populations (e.g., paediatrics) and/or specialized programs (e.g., cardiac surgery) which have significant resource and planning implications;

iii the BULP methodology be repeated at selected intervals to determine if there are significant changes in utilization patterns by levels of care over time, as modes of medical practice and technological applications change;

iv a panel of experts be established to assess the level of care requirements of patients based on disease codes and/or treatment data, and the results be compared to those obtained from the BULP methodology in order to establish an alternative measure of the utility of the BULP methodology;

v the results of the BULP methodology and its utility in explaining interhospital cost variations be assessed using more sophisticated econometric models, in order to re-evaluate the cost relationships obtained in this study; and,

vi comprehensive studies of the relationship between nursing and other major departmental costs, and between nursing department costs and levels of care be undertaken, which would assist in evaluating the efficient and effective allocation of funds across hospitals providing different levels of care.

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APPENDIX A:

LIST OF ABBREVIATIONS

LIST OF ABBREVIATIONS

ADM	-	Administration and Support Services Departments
AHMC	-	Alberta Hospitals and Medical Care
ALOS	-	average length of stay.
BULP	-	bed utilization by levels of care profile
CDC	-	Canadian Disease Classification
CI	-	commitment index
CL	-	Calgary Region
CPHA	-	Commission on Professional and Hospital Activities
DIAG	-	Diagnostic/Therapeutic Departments
DIST	-	hospital district
DRG	-	diagnostic related grouping
ED	-	Edmonton Region
GP	-	Grande Prairie Region
H-ICDA	-	Hospital Adaptation of the International Classification of Diseases
HOSP	-	hospital
LB	-	Lethbridge Region
Level 1	-	primary care
Level 2	-	secondary care
Level 3	-	tertiary care
LOS	-	length of stay
MH	-	Medicine Hat Region
NSG	-	Nursing Department
NRA	-	North Referral Area
PAS	-	Professional Activities Study
PDAY	-	patient day
RD	-	Red Deer Region

REGION	-	regional hospital groupings
R.I.	-	relevence index
SEP	-	patient separation/discharge
SP	-	service population
SSI	-	self sufficiency index
SRA	-	South Referral Area

APPENDIX B:

COPY OF THE PAS CASE-ABSTRACT FORM

23456 7890

PAS

1978 CASE ABSTRACT
ALBERTA

78

78 78

SEPARATION STATUS

EXPECTED PAYMENT

CASE UNITS

SEX: Male, Female

ADMISSION: Emergency, Urgent

RACE: White, Black, Asian, Other, Indian

DIAGNOSES

12

TEMPERATURE

ADMISSION BLOOD PRESSURE

BIRTH WEIGHT

WEIGHT

HEIGHT

COMPLICATION

SURGEON A

SURGEON B

OTHER THERAPY

LAB TESTS AND X-RAYS

X-RAY: Chest

HISTOLOGY

PAS Form (Alberta) Printed in U.S.A. 1978

APPENUIX C:

LIST OF HOSPITAL DISTRICTS AND ACUTE CARE HOSPITALS INCLUDED IN THE STUDY

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
1	Mannville M.H.D.	77	Mannville Mun.	Mannville	28
2	Vermilion M.H.D.	108	Vermilion Mun.	Vermilion	52
3	Drumheller G.H.D.	36	Drumheller Gen.	Drumheller	70
4	Islay M.H.D.	64	Islay Mun.	Islay	28
5	Cardston M.H.D.	23	Cardston Mun.	Cardston	61
6	Bassano M.H.D.	5	Bassano Gen.	Bassano	30
7	Drayton Valley M.H.D.	35	Drayton Valley Mun.	Drayton Valley	47
8	[f]Lloydminister M.H.D.	-	-	-	-
9	Hanna G.H.D.	57	Hanna Gen.	Hanna	50
10	Viking M.H.D.	109	Viking Gen.	Viking	35
11	High River G.H.D.	60	High River Gen.	High River	64
12	Provost G.H. & N.H.D.	89	Provost Gen.	Provost	31
13	Athabasca M.H.D.	1	Athabasca Mun.	Athabasca	45
14	Grande Prairie G. & A.H. & N.H.D.	56	Grande Prairie Mun.	Grande Prairie	130
15	Red Deer M.H.D.	92	Red Deer Gen.	Red Deer	223

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
16	Innisfail M.H.D.	63	Innisfail Gen.	Innisfail	55
17	Wainwright G. & A.H. & N.H.D.	112	Wainwright Gen.	Wainwright	48
18	Elk Point M.H.D.	46	Elk Point Mun.	Elk Point	42
19	Vulcan M.H.D.	111	Vulcan Mun.	Vulcan	37
20	Stettler G. & A.H. & N.H.D.	97	Stettler Mun.	Stettler	50
21	Peace River M.H.D.	85	Peace River Mun.	Peace River	71
22	Consort M.H.D.	30	Consort Mun.	Consort	22
23	Myrnam M.H.D.	82	Myrnam Mun.	Myrnam	20
24	Claresholm M.H.D.	27	Claresholm Mun.	Claresholm	47
25	Little Bow M.H.D.	24	Little Bow Mun.	Carmangay	16
26	Olds M.H.D.	83	Olds Mun.	Olds	43
27	Taber M.H.D.	100	Taber Gen.	Taber	66
28	Brooks G.H.D.	14	Brooks Gen.	Brooks	65
29	Magrath M.H.D.	75	Magrath Mun.	Magrath	26
30	Eckville M.H.D.	37	Eckville Mun.	Eckville	26
31	Raymond M.H.D.	91	Raymond Mun.	Raymond	50

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
32	Beaverlodge-Hythe G.H.D.	6 62	Beaverlodge Mun. Hythe Mun.	Beaverlodge Hythe	30 10
33	Didsbury M.H.D.	34	Didsbury Mun.	Didsbury	34
34	Vegreville G.H.D.	107	St. Joseph's Gen.	Vegreville	70
35	Oyen M.H.D.	84	Big Country	Oyen	34
36	St. Paul G.H.D.	99	St. Theresa Gen.	St. Paul	75
37	Ponoka G.H. & N.H.D.	88	Ponoka Gen.	Ponoka	50
38	Mayerthorpe G.H.D.	78	Mayerthorpe Mun.	Mayerthorpe	22
39	Coronation M.H.D.	31	Coronation Mun.	Coronation	25
40	Crowsnest Pass G.H. & N.H.D.	9	Crowsnest Pass Gen.	Blairmore	60
41	Castor M.H.D.	25	Our Lady of the Rosary	Castor	30
42	Two Hills M.H.D.	105	Two Hills Mun.	Two Hills	37
43	Bentley M.H.D.	7	Bentley Gen.	Bentley	16
44	Elnora M.H.D.	47	Elnora Gen.	Elnora	16
45	Three Hills M.H.D.	101	Three Hills Mun.	Three Hills	21
46	Cereal M.H.D.	26	Cereal Mun.	Cereal	9

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
47	Tofield M.H.D.	102	Tofield Mun.	Tofield	31
48	MacLeod M.H.D.	50	MacLeod Mun.	Fort MacLeod	32
49	Rocky Mountain House M.H.D.	94	Rocky Mountain House Gen.	Rocky Mtn. House	47
50	Berwyn M.H.D.	8	Berwyn Mun.	Berwyn	21
51	Sundre G.H.D.	119	Sundre Gen.	Sundre	34
52	Rimbey M.H.D.	93	Rimbey Gen.	Rimbey	31
53	Empress M.H.D.	48	Empress Mun.	Empress	17
54	Lacombe G.H.D.	68	Lacome Gen.	Lacombe	50
55	Flagstaff-Hughenden G.H.D.	32	Daysland Gen.	Daysland	30
		54	Galahad Gen.	Galahad	40
		58	Hardisty Gen.	Hardisty	20
		66	Killam Gen.	Killam	30
56	Trochu M.H.D.	103	St. Mary's	Trochu	30
57	Glendon M.H.D.	55	Glendon Mun.	Glendon	8
59	Fairview M.H.D.	49	Fairview Mun.	Fairview	50
60	Spirit River G.H.D.	96	Central Peace Gen.	Spirit River	47
61	Boyle G.H.D.	12	Boyle Gen.	Boyle	30
63	Grande Cache G.H.D.	121	Grande Cache Gen.	Grande Cache	

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
64	Lamont-Mundare-Willingdon G.H.D.	69	Archer Memorial	Lamont	72
		81	Mary Immaculate	Mundare	18
		115	Mary Immaculate	Willingdon	25
65	Lethbridge G.H.D.	28	Coaldale Community	Coaldale	25
		71	Lethbridge Mun.	Lethbridge	206
		72	St. Michael's Gen.	Lethbridge	207
66	Turner Valley M.H.D.	104	Turner Valley Mun.	Turner Valley	24
67	Barrhead G.H.D.	3	Barrhead Gen.	Barrhead	80
69	Medicine Hat G.H.D.	79	Medicine Hat Gen.	Medicine Hat	237
70	Manning M.H.D.	76	Manning Mun.	Manning	34
71	Banff G.H.D.	2	Mineral Springs	Banff	46
72	Bow Island G.H.D.	11	Bow Island Gen.	Bow Island	39
73	Smoky Lake M.H.D.	95	George Mcdougall Memorial	Smoky Lake	25
75	Cold Lake G.H.D.	29	John Neil	Cold Lake	27
		302	Department of National Defense	Medley	50
76	Hinton G.H.D.	61	Hinton Mun.	Hinton	27
78	Lac La Biche G.H.D.	67	Lac La Biche Gen.	Lac La Biche	68

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
79	Pincher Creek G.H.D.	87	Pincher Creek Health Centre	Pincher Creek	56
80	Canmore M.H.D.	22	Canmore Mun.	Canmore	20
81	Wetaskiwin M.H.D.	114	Wetaskiwin Mun.	Wetaskiwin	135
82	Picture Butte M.H.D.	86	Picture Butte Mun.	Picture Butte	25
83	Leduc G.H.D.	70	Leduc Mun.	Leduc	35
84	Stony Plain M.H.D.	98	Stony Plain Mun.	Stony Plain	30
85	Breton G.H.D.	13	Breton Gen.	Breton	25
86	Edson G.H.D.	45	St. John's	Edson	50
87	Jasper G.H.D.	65	Seton Gen.	Jasper	33
88	Bonnyville G.H.D.	10 501	St. Louis Duclos	Bonnyville Bonnyville	52 18
89	High Prairie G.H.D.	59	Regional Health Complex	High Prairie	72
90	McLennan G.H.D.	74	Sacred Heart	McLennan	61
91	Westlock M.H.D.	113	Immaculata	Westlock	80
92	Camrose G.H.D.	21	St. Mary's	Camrose	117

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
93	Metropolitan Calgary	15	Alberta Children's Provincial	Calgary	128
		16	Foothills Provincial General	Calgary	784
		17	Calgary Gen.	Calgary	928
		19	Holy Cross	Calgary	532
		18	Salvation Army Grace Gen.	Calgary	100
		20	Rockyview Gen.	Calgary	194
94	Bashaw G.H.D.	4	Bashaw Gen.	Bashaw	30
95	Border Counties G.H.D.	80	Border Counties Gen.	Milk River	30
96	Valleyview G.H.D.	106	Valleyview Gen.	Valleyview	35
97	Whitecourt G.H.D.	116	Whitecourt Gen.	Whitecourt	34
98	Fort Saskatchewan G.H.D.	52	Fort Saskatchewan Gen.	Fort Saskatchewan	42
99	Fort McMurray G.H.D.	117	Fort McMurray Regional	Fort McMurray	73
100	Sturgeon G.H.D.	120	Sturgeon Gen.	St. Albert	100
101	Slave Lake G.H.D.	118	Slave Lake Gen.	Slave Lake	34
102	Fort Vermilion G.H.D.	53	St. Theresa Gen.	Fort Vermilion	36
		123	High-Level Community Health centre	High Level	25
103	Thorhild County G.H.D.	122	Redwater Gen.	Redwater	32

List of Hospital Districts and Acute Care Hospitals Included in the Study

District I.D. Code[a]	Hospital District[b]	Hospital I.D. Code[c]	Hospital Name[d]	Location	Number of Beds[e]
105	Vilna G.H.D.	110	Our Lady's	Vilna	14
106	Metropolitan Edmonton	38	Dr. W.W. Cross Cancer Institute	Edmonton	76
		43	Royal Alexandra	Edmonton	977
		44	University of Alberta	Edmonton	1236
		303	Charles Camsell	Edmonton	365
		39	Edmonton Gen.	Edmonton	559
		41	Misericordia	Edmonton	555
149	Devon Area H.D.	33	Devon Civic	Devon	12
150	[f]Blood I.R.	-	-	-	-
154	[f]County of Wheatland Area	-	-	-	-

Note: Source: Alberta Department of Hospitals and Medical Care, 1981.

[a]Identification codes specific for each Hospital District

[b]Abbreviations: 1) M.H.D. - Municipal Hospital District; 2) G.H.D. - General Hospital District; 3) G.H. - General Hospital; 4) A.H. - Auxilliary Hospital; and 5) N.H.D. - Nursing Home District.

[c]Identification codes specific for each Acute Care Hospital.

[d]Abbreviations: 1) Mun. - Municipal, and 2) Gen. - General.

[e]Numbers of rated beds in each hospital (Hospital Care in Alberta, Statistical Supplement for Year Ending March 31, 1979,) Alberta Hospitals and Medical Care, Undated.

[f]Hospital Districts without hospitals.

APPENDIX D:

FORMULAE FOR RELEVANCE AND COMMITMENT INDICES

Formulae for Relevance and Commitment Indices

Relevance Index of the Local Hospital to the Local Hospital District equals

$$\frac{\text{Number of a Local District's Patients separated from Local Hospital(s)}}{\text{TOTAL number of a Local District's Patients separated}}$$

Relevance Index of Other Districts' Hospitals to the Local District equals

$$\frac{\text{Number of Local District's Patients Separated from Specific Non-Local Hospitals}}{\text{Total Number of Local District's Patients Separated}}$$

Commitment Index of a Hospital to its Local Hospital District equals

$$\frac{\text{Number of Local District's Patients Separated from the Local Hospital(s)}}{\text{Total Number of Patients separated from the Local Hospital}}$$

Commitment Index of a Hospital to Non-Local Hospital Districts equals

$$\frac{\text{Number of Patients from Specific Non-Local Districts Separated from the Local Hospital(s)}}{\text{Total Number of Patients Discharged from the Local Hospital}}$$

PDAYs may be substituted for SEPs in calculating these indices.