FORECASTING ACUTE-CARE
HOSPITAL BED DEMANDS
USING INTRA-REGIONAL TRANSFERS

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ABSTRACT

Governments in this country have a mandate from their electorate to obtain the best social return from public investment in health care. Because of escalating capital and operating costs, the acute-care-hospital component of health care has recently come under close scrutiny. Accordingly, governments must forecast public demands for hospital services in order to plan the most effective and efficient delivery of these expensive hospital services. This thesis examines the British Columbia Ministry of Health's current method of forecasting acute-care-bed requirements which has been applied to the Greater Vancouver Regional Hospital District (G.V.R.H.D.) and then proposes an improved method which accounts for the movement of hospital patients from their district of residence to a district providing hospital services.

A computer forecasting program was designed using the Provincial forecasting method as a base with the addition of a Transfer Matrix that distributes the acute-care patient-days generated by each of the G.V.R.H.D.'s districts to those districts that provide hospital services. With this addition, the computer forecasting program better reflects the G.V.R.H.D.'s current source and distribution of the demand for hospital service. The computer forecasting program was verified by comparing its Standard Forecast to a manually calculated forecast.

The program was then used firstly to analyse the sensitivity of the forecast of Hospital-Bed Requirements to changes in the values of the Population and Incidence Rate variables, and secondly, to analyse the effects of alternate policies regarding the input values of the program's variables.
Firstly, the sensitivity analysis showed that if certain equal changes are made to the values of input variables, the sensitivity of the output forecast can vary among the districts. This aspect of the forecast enhances the value of the program as a method of analysing unexpected relationships. Secondly, the policy analysis showed that the computerized forecasting program can quickly produce alternate forecasts that correspond to alternate policies regarding the values selected for the program's variables. The policy-maker can then analyse the effects of these policies and thus be in a better position to weigh the costs and the benefits involved.

For these reasons, the computer forecasting program developed for this thesis is an improvement over the current method used in British Columbia. However, the thesis does describe other current techniques that can, and should, now be incorporated into the computer forecasting program to offer more flexibility when analysing the effects of possible future conditions.

Supervisor
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CHAPTER I

INTRODUCTION

Hospitals are creatures of their local community, and often of only segments of the community. In general, they represent the feelings, rather than the considered judgements of their community. (Brown, 1967)

This thesis studies the planning of future acute-care-hospital bed requirements which is one aspect of planning for health services. Although many techniques have been developed to assist in the hospital-planning process, their effectiveness has been limited by the fact that frequently there have been no specific policies that first set the objectives for the planning process.

This study reviews the history of planning for future hospital-bed requirements and the conceptual problems inherent in techniques that forecast future requirements. It improves upon the forecasting technique used by the British Columbia Ministry of Health which incorporates several generally recognized components but falls short of the state-of-the-art methods of analysing and forecasting the interrelationships among regional population groups and their hospitals.

Specifically, the following problems have been addressed in this thesis:

1. To develop and validate a computerized method of forecasting future acute-care-hospital bed requirements based on the current British Columbia Hospital Programs' method, but with the addition of a matrix to account for patient transfers within a region and,

2. To examine the sensitivity of the developed method to selected input variables for which inaccuracies could occur in their predicted values and,
3. To study the effects of alternate policy decisions in the following areas:
   a. Population
   b. Incidence Rates of Hospitalization
   c. Inflow
   d. Intra-Regional Patient Transfers
   e. Hospital Occupancy Percentage.

The problems addressed are very narrow in conceptual scope, but their resolution depends on a logical understanding of their relationship to the broader concepts of planning health services now discussed.

If our community had unlimited resources to meet its perceived health-care needs, there would be no requirement to allocate or ration resources - no requirement to plan. Because this is not so, systems have evolved to ration our limited resources within a spectrum ranging from political edict to open market with a price system. To the extent that these systems prove effective, they will balance overall community needs now and in the future. Unfortunately, there is no general agreement that our resource allocation systems are effective.

In the health care sector, rapidly rising costs are usually viewed as a signal that the resource allocation system is out of control. The prediction of the Economic Council of Canada, that expenditures on health care and education would theoretically soon consume the entire Canadian Gross National Product unless changes are made, is constantly in the background (Economic Council of Canada, 1970). Better "planning" and thus better allocation is heralded as the answer.

But what is planning? It is an activity that has been described as vaguely as the process of thinking before you act (Gottlieb, 1974) and as specifically as the development and implementation of a course of action which is expected to lead to desired results given the occurrence of expected events (Bergwall et al., 1974).
Planning is an activity that is concerned with the future having resulted from an alteration of the present or, as it is defined for this study, it is the management of the future.

This definition of planning implies the setting of goals and the organization of effort to attain them, and opens the question of who should plan for future health services. Clearly, the agency responsible for the supply of resources has a mandate to ensure the most effective use of those resources - a mandate to plan.

There is much debate in the United States over this question as the health sector and, specifically, hospitals struggle to remain independent in a market economy. However, any agency that wishes to plan the relationship of hospitals to other health care and other community requirements must be able to implement its strategies. The U.S. Public Health Service recognizes the need for planning due to cost escalations and population changes, but maintains that hospitals should remain independent (U.S.P.H.S., 1961). This independence is cited by May (1976) as one reason for the disappointing performance of America's layers of planning legislation. Because most American hospital users still pay for services directly to the hospitals or through third party insurers, the State has been in a weak position in proposing central control since it has not been directly involved in the transaction between the patient and the hospital. Recent U.S. government participation in Medicare and Medicaid, however, has created a financial lever that may be used to attain planning goals.

In Canada, the health-care system is different from that in the U.S.A., in that the federal and provincial governments finance both hospital care and the major portion of hospital construction, thus acting as third party agencies on behalf of the consumer.
This centralization of funding has created a legitimate base for central planning, but it has also created a problem in matching the demand and supply of hospital services. The consumer demands health care as a right, but is not required to regulate his demands since the consumer-provider market system has been replaced by "insurance". The State reacts to these demands by regulating the supply of hospital services according to its fiscal resources. To complete the circle, the consumer usually resists the tax increases that the State requires to meet the consumer's increasing demands. Thus, this centralization of funding has removed the consumer from the connection between service and its cost. The problems created by unregulated demands are discussed later in this study.

In spite of these problems, the State attempts to obtain a balance in the hospital system by altering the supply of hospital services to meet the demand expressed by consumers. Since there is a lead-time of several years between the initiation and the completion of hospital facilities, current plans must be based on estimates of future demand if a balance is ever to be reached between supply and demand.

This thesis studies the process of estimating, or forecasting, the future demand for hospital facilities and it refines one established forecasting technique to provide for rapid analysis of policy alternatives through use of a forecasting program on a computer. Finally, the study examines the sensitivity of the technique to changes in the value of input variables.

It must be clearly stated at the onset that systems-analysis techniques such as forecasting cannot, and should not, be expected to replace goal setting and decision making; rather, they provide information to aid the policy makers. To be effective, these techniques must not only be theoretically sound, but must also successfully analyse real problems. (Bailey, 1975).
CHAPTER II

PROBLEMS OF FORECASTING
ACUTE-CARE-HOSPITAL
BED REQUIREMENTS

Hospital planning is ultimately subjective. If we try to persuade ourselves that it is objective, we are deceiving ourselves. (Hudenburg, 1967)

Canadian governments have removed most of the health care industry from the market economy. This was not done as a contentious move to control, but as an innocuous move to "insure" individuals against the high costs of necessary health services. Government now "reimburses" health care suppliers by acting as the agent of the consumer.

Rapidly rising capital and operating costs in hospitals have forced governments to determine whether the care consumed is reasonable. The State is expected to provide health care services quickly in response to consumer demands and also to manage the taxpayers' funds prudently. These two tasks often conflict! The State must ration its limited resources to society's overall demands and thus must compare the perceived health-care needs of the consumer with the demands expressed by other sectors of society. In relation to hospital services, the question the State must ask is, what IS the type and quantity of acute-hospital care that society should have?

A spontaneous response might be "provide what the community needs". This is an idealized approach but one that is difficult to implement. Griffith (1972) defines need as a "concept of health service required by a population to maintain it at a preconceived level of health". This value-laden concept is all but impossible to measure. Unless detailed and expensive surveys of the health status of the population are conducted,
the true need for hospital services cannot be known.

The popular substitute for need is demand; "the sum of explicit requests for a given medical care service either by the patient...or the doctor..." (Griffith, 1972). Newhouse (1971) suggests abandoning the ineffective concept of "need" and using instead a prediction of future demand for services and provision of the necessary corresponding resources. The disadvantage of using this substitute is that such factors as economic status, social pressures, and availability of resources distort true need into demand for services. The advantage of this substitute is that demand is expressed in activity that can be easily measured. By accepting demand as a substitute for need, a judgement is made that measurability is more important to planning than is pertinence.

Demand is expressed in the utilization of acute-care facilities; particularly by admissions to hospitals and the number of days that hospital beds are occupied. When utilization is expressed as a ratio of hospital bed days used (or patient days) per 1000 persons, it is labelled "THE INCIDENCE RATE OF HOSPITALIZATION" (Griffith, 1972). Definitions of such terms used in this study are contained in the Glossary. This rate, when calculated from current data, is used as an indicator of the current acute-care demand of a population. When projected to a future point in time, the rate is used to estimate future demand for hospital beds.

The supply of acute-care-hospital beds has a strong influence on the utilization of those facilities by the community. The concept that supply creates, within some limits, its own demand (Abel-Smith, 1962) has focused attention on the number of acute-care-hospital beds as a key to attaining more "reasonable" demands on the public treasury. The study by Roemer and Shain (1959) supports the argument that empty hospital beds are
soon filled and thus that the supply of beds is directly linked to costs. This argument states that as beds are added in response to demand, they are soon occupied and this utilization is then used as a base for requesting more beds in the future. The spiral must, in practice, end at a finite bed-count. This stabilized bed-count may not reflect the true requirements for acute-care facilities as consumers may be inappropriately placed. These people may shift to less costly alternatives, when provided, and leave the acute hospitals with inefficient occupancy levels. Ensminger (1975) claims that this is the current situation in the United States with higher-than-necessary costs for hospital care due to the over-building of facilities. Quality of care may suffer in this situation as independent hospitals and their physicians compete for patients and also drain staff and resources from public hospitals.

The next major conceptual hurdle in the planning process is the projection or forecast of hospital utilization. The sophisticated statistical tools usually used to produce this forecast do not create quantitative forecasts without the input of qualitative judgements. Martin (1975) correctly comments, "...no matter how complex the mathematics of the particular technique appear, every forecasting technique is a mix of two basic elements, projection of past trends and educated guesses." The distinction between these two elements implies serious policy implications.

For example, if current utilization is applied to a future time, or if past trends are extrapolated into the future, the implicit assumption is that no change from the status quo is anticipated. Since hospital care is dynamic, this is a dubious assumption. The second element, the educated guess, is interpreted here to mean either the identification and examination of factors that may alter current demand or the establishment of normative
demand levels. The first element, the examination and projection of past trends, is deterministic; the second, the educated guess, is dynamic and implies conscious policy formation.

Assuming that educated guessing is necessary, how does one establish normative utilization rates; how much hospital care is enough?

Hoge (1958) notes that normative utilization rates have been established, but that they have been made equal to existing hospital utilization. This acceptance of the status quo as a norm may be a mistake since there may be unexpressed demand due to a shortage of hospital facilities or over-utilization of hospital facilities due to a high physician-per-population ratio. For example, if a population unit has insufficient hospital services to meet its legitimate demands, utilization rates expressing the full use of these facilities will only indicate what hospital use has occurred, not what use would have occurred if more facilities had been available. The formalizing of the current utilization rate as a norm for future planning would perpetuate the inadequacy of the present situation. Alternatively, the current hospital utilization rate may reflect an over-utilization of facilities. For example, if a population unit has more physicians than are required to meet its legitimate medical demands, hospitals may be inappropriately over-used rather than physicians being appropriately under-used. Again, establishment of this inflated hospital incidence rate as a norm will not alter the future situation as an improvement on the present.

It is clearly difficult to judge the appropriateness of current hospital utilization rates. Actual hospital occupancy rates and patient waiting lists can assist in this review, but they can be influenced by such qualitative factors as the local patterns of medical practice and the efficiency of the hospitals' management.
The appropriateness of local hospital utilization rates may be assessed by comparing local rates with the utilization experience of other countries and different health-care-delivery systems, but this may yield inconclusive results as the following example shows.

Anderson (1972) reported that the 1968 average INCIDENCE RATE OF HOSPITALIZATION for the free-enterprise U.S.A. was 1154/1000 while those of Socialist Sweden and England were 1569/1000 and 1132/1000 respectively. No clear pattern emerges from these few samples.

Similarly, local INCIDENCE RATES may be compared within a regional area in an attempt to set norms for future planning.

Table One shows the age-specific adult INCIDENCE RATES for districts within Greater Vancouver for the years 1971 and 1975.

TABLE I

ANNUAL INCIDENCE RATE OF HOSPITALIZATION
PER 1000 PERSONS
AGE GROUP 15 - 69

<table>
<thead>
<tr>
<th>Districts</th>
<th>1971</th>
<th>1975</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>1292</td>
<td>1141</td>
</tr>
<tr>
<td>Delta</td>
<td>881</td>
<td>828</td>
</tr>
<tr>
<td>Richmond</td>
<td>907</td>
<td>867</td>
</tr>
<tr>
<td>Vancouver</td>
<td>1374</td>
<td>1352</td>
</tr>
<tr>
<td>New Westminster</td>
<td>1208</td>
<td>1275</td>
</tr>
<tr>
<td>Burnaby</td>
<td>976</td>
<td>941</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>891</td>
<td>912</td>
</tr>
<tr>
<td>North Vancouver</td>
<td>1247</td>
<td>1035</td>
</tr>
<tr>
<td>West Vancouver</td>
<td>1023</td>
<td>941</td>
</tr>
<tr>
<td><strong>TOTAL POPULATION</strong></td>
<td>1202</td>
<td>1136</td>
</tr>
</tbody>
</table>

Two of the areas with low utilization, Delta and Coquitlam, do not have local community hospitals. However, other indicators would need to be studied to determine whether these two areas were low because of insufficient supply of hospital beds or whether the other areas were high because of an oversupply of beds. Such an analysis
might lead to reasonable norms for demand.

Although the establishment of norms is difficult, forecasting demand cannot be a useful technique in the cost-reducing planning process unless existing patterns of utilization are changed. Paul Ellwood in a summary to a work by Melum (1975) states that sophisticated formulas, giving the appearance of precision, act as mathematical "security blankest" and that health care costs will not be contained unless "courageous criteria" are used in the forecasting of future demands. In other words, Elwood believes that the present utilization of hospital facilities is not ideal and that future utilization should be forced downward by restricting the supply of acute care facilities. This statement implies that, in general, acute-care-hospital facilities are inappropriately used and that lower-cost alternatives should be made available to meet the consumer's perceived needs for hospital care.

As stated earlier, the two elements of a forecasting technique are, firstly, projections of past trends and, secondly, educated guesses. Too often, a simple extrapolation of a past trend is used to arrive at a forecast without addressing the problems involved in making educated guesses about value-laden issues.

An extrapolation forecast makes these guesses, or policy decisions by default; it assumes a continuation of the status quo. These two elements must be combined and the implicit policy decisions must be stated clearly if the resulting forecast is to be effective.

This chapter has outlined the following basic conceptual problems involved in planning acute-care-hospital requirements: the concept of need vs. demand, the State as a third party in the con-
sumer-provider relationship, the appropriateness of current hospital utilization, and, the projection of trends. Since it is unlikely that these problems will be resolved, the following comment by Sir George Godber (Tottie, 1967) may be ironically appropriate:

"Although the number of beds is a poor measure of hospital need, it does give a general guide and it is the only unit in common use."
12.

CHAPTER III

THE DEVELOPMENT OF TECHNIQUES FOR FORECASTING THE DEMAND FOR ACUTE-CARE-HOSPITAL BEDS

"Determining bed need, at best, is an educated guess; but, in all probability, is better than an uneducated one." (Hudenburg, 1967)

Current techniques used to forecast the future demand for acute-care-hospital beds have resulted from past inquiries into the status of hospital bed supply. It is relevant to this thesis to trace this development by looking at selected developments which can put the current state-of-the-art into perspective.

One of the earliest formal recognitions of the need to plan the development of hospitals was made by the New York Academy of Medicine in 1920 (U.S.P.H.S., 1958). This study used a U.S. Public Health Service estimate that two per cent of the population would be ill at any point in time. Thus, by surveying 180 general hospitals in New York City, it was determined that there were 5 beds per 1,000 people, or one bed for every fourth ill person. The Academy felt that this was sufficient. This uncomplicated approach has the basic elements of a forecast, namely, a quantitative measure of current demands and a prediction of future demand. Specifically, the measure of current demand was five beds for every 1,000 persons and the prediction of future demand was their decision that this usage was acceptable and the assumption that this bed per population ratio should be applied to future populations to determine future hospital bed requirements.

The economic depression of the 1930's limited the growth of
hospitals, although the U.S. government began a grant-in-aid program in 1933 to use hospitals as public works projects (Hodge, 1958). The manpower and material shortages experienced during World War II aggravated this already slow growth in the hospital bed supply. During this war, many countries recognized that changes in the post-War hospital sector would be necessary. Britain planned to reorganize its entire health services while Canada and the U.S. planned incentives for the construction of new hospital facilities.

The Commission on Hospital Care examined the status of hospital facilities in the United States in the early 1940s (Commission on Hospital Care, 1947). After exploring the difficulties of determining need, which are outlined in Chapter II, the Commission used the death rate of the population as an indicator of the prevalence of sickness in the population. They also determined that, on the average, 250 patient-days of care are provided by hospitals for every death occurring in hospitals (total patient-days/deaths in hospitals); this is equivalent to approximately 0.7 hospital beds for each death occurring in one year (250 days/365 days) at 100% occupancy. Since the gross death rate of the population was known, 10.1%/year., as well as the proportion of total deaths that occur in hospitals, 50%, it was possible to forecast the future hospital requirements as described in Table II.
TABLE II
FORECASTING TECHNIQUE
USED BY
THE COMMISSION ON HOSPITAL CARE
U.S.A.

1. Forecast Annual Deaths in Hospitals per 1000 Persons = Forecast Annual Deaths per 1000 Persons + Forecast Proportion of Total Deaths Occurring in Hospitals

Example:
5.05/1000 - yr. = 10.1/1000 - yr. + 0.5

2. Forecast Annual Hospital-Bed Requirement at 100% Occupancy Per 1000 Persons = Forecast Annual Deaths in Hospitals per 1000 Persons X 0.7 Beds per Hospital Death

Example:
3.54/1000 - yr. = 5.05/1000 - yr. X 0.7

3. Forecast Annual Hospital-Bed- Requirement at Desired Occupancy Percentage = Forecast Annual Requirement at 100% Occupancy + Desired Occupancy Percentage

Example:
4.71/1000 - yr. = 3.54/1000 yr. + 75%
This calculation used a 1944 U.S. death rate and a projected 1946 proportion of deaths in hospitals to forecast a 1946 requirement of approximately five hospital beds per 1000 persons. The Commission forecast the requirement for maternity beds separately, in particular the forecast number of these beds were directly related to the number of births occurring in hospitals.

The practical operation size of hospitals within the established geographic areas was determined from the average daily requirement for beds, the AVERAGE DAILY CENSUS. Because hospitals with a low average daily census were unable to maintain a high occupancy, the planned occupancy rates for the hospitals varied with the expected average daily census.

These refinements enabled the study to vary the supply of hospital beds to suit local conditions, providing a better approach than earlier fixed ratios per population unit.

This work of the Commission on Hospital Care in the United States resulted in the Hospital Survey and Construction Act (Hill-Burton) of 1946 (Somers, 1969). This Act was designed to provide federal funds for local hospital construction on a cost-sharing basis, provided that each state conducted a survey of current assets and projected demands. The specified forecasting formula applied the current incidence rate for an area to an estimate of the future population. This projected annual demand in hospital patient-days was converted to hospital bed-equivalents and adjusted by the desired occupancy of the hospitals to yield the projected demand for hospital beds. These steps are summarized in Table III.
TABLE III
FORECASTING TECHNIQUE
USED BY
THE HOSPITAL SURVEY AND CONSTRUCTION ACT
U.S.A.

<table>
<thead>
<tr>
<th>Forecast</th>
<th>Current</th>
<th>Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Demand</td>
<td>Incidence Rate X</td>
<td>Population</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>of Hospitalization</td>
<td>(Population in 1000's)</td>
</tr>
<tr>
<td>(Patient-Days/yr.)</td>
<td>(Patient-Days/yr.)</td>
<td></td>
</tr>
</tbody>
</table>

2. Forecast Average Daily Census = Forecast Total Annual Demand For Hospitalization + 365 (Patient-Days/yr) = (Patient-Days/yr) (days/yr.)

3. Forecast Hospital Bed Need = Forecast Average Daily Census Desired Occupancy +10 Percentage Beds/day (Patient-Days/day) ( % ) (Beds) (or Beds/Day)
Initially, the Occupancy Percentage was set at 80% (or 0.8) with the additional 10 beds as an adjustment for small hospitals that are unable to maintain this desired occupancy. Note here that, for simplicity, the method of varying the desired Occupancy Percentage in relation to the expected Average Daily Census of each hospital used by the Commission on hospital care, was not incorporated into the Hill-Burton formula. Subsequently, in 1972, the occupancy rate was raised to 85% and in 1973, the addition of 10 beds was deleted from the formula.

This Act required the establishment of state planning agencies as a condition for federal participation in hospital construction programs and it provided the agencies with a uniform planning method. In recent years, however, the planning method has been criticized (Hill, 1971) because it assumes that current usage as expressed as the Incidence Rate is legitimate and then applies that Incidence Rate to future population estimates. If the current Incidence Rate is inappropriate for whatever reason, the discrepancy can be compounded in the future, as was explained in Chapter II. However, despite its theoretical deficiencies, the Act did stimulate hospital construction in a period of generally agreed shortage.

Canada, like the United States, experienced a post-World War II shortage of hospital facilities. The Canadian government implemented a National Health Program in 1948 to provide federal funds on a cost-shared basis to provinces for acute-care-hospital construction. Like the Hill-Burton program, federal grants were conditional on provincial surveys of health services.

The hospital-insurance program of the Province of British Columbia, therefore, required a comprehensive analysis of hospital needs and such a study was commissioned (Hamilton, 1949). The hospital
plan subsequently recommended was based on forecasts of "need" using the bed/death and bed/birth methods of the Commission on Hospital Care discussed earlier. The plan specified hospital regions created from census tract divisions with a three-tiered structure of community clinics, community hospitals and regional hospitals. Some of these regional hospitals were teaching centres. Some 15% of demand at the community clinic and hospital level was to be referred to regional hospitals and a further 5% to the teaching hospitals. The Plan's forecast for 1971 was a bed/1000 population ratio of 7.09. Compared with recent standard of 4.25* this is an incredibly high ratio, which may indicate the perils of forecasting for a 20 year period!

Further work was done in British Columbia in the early 1950s to determine the number of acute-care-hospital beds needed for the Lower Fraser Valley Hospital Region. The work was done by the former B.C. Department of Health and Welfare (Grigg and Whelen, 1954), based on 1952 data from the newly formed B.C. Hospital Insurance Service. Past trends in hospitalization, projected population growth, transportation facilities and inter-regional relationships were examined to forecast the change in the total number of patient-days over a time period. The reason for the use of total patient-days as a base for the forecast rather than the more usual rate of patient-days per 1,000 population is curious, and not explained. This work, however, did contribute a new feature to the growing list of sophisticated forecasting techniques. Specifically, since accurate information on

* 1977 B.C. Hospital Programs
Provincial Average-Care-Hospital Bed per 1000 Target Ratio.
hospital usage was available from the new universal hospital-insurance program, the source and distribution of patients was known and could, therefore, be used in forecasting the future demand at Lower Fraser Valley hospitals.

In the mid 1950s, the Swedish hospital system was reorganized to overcome the limitations experienced by the 25 independent county councils responsible for hospital care due to their overall population bases. After transportation and geographic studies were conducted, the country was divided into several self-sufficient hospital regions, each serving approximately one million persons. Each region has a regional hospital offering specialized services as well as county and community hospitals in a three-tiered system. In determining the organization of facilities, the optimal size of departments for needed services was considered along with the usual demographic characteristics of the population. Using fifteen years of experience, standard sized units were determined for medical specialities with bed-to-population ratios. Tottie and Janzon (1967) report that the bed-to-population ratios were used as a guide in the forecasting of demand but that social factors such as housing and family care of the aged as well as geographic factors were important considerations in the allocation of future facilities. This extensive national plan was mainly based on subjective judgements of local conditions but it did add to the planning art the techniques of developing and using ratios of specialty-beds-to-population and, after the total number of specialty beds had been determined, establishing rationally sized groups of specialty beds.

In Great Britain, following World War II, the creation of the National Health Service reorganized the delivery of medical and
hospital care. However, no explicit forecast was made of the future
demand for hospital facilities. By 1962, national standards were
A 3.3/1,000 hospital-bed-to-population ratio was set for acute care
and a 0.58/1,000 ratio was set for maternity. The combined 3.9 bed
to population ratio appears as a target to be met rather than as an
estimate of consumer demand because the 1966 statement on the build­
ing program emphasizes that acute care is not the whole picture and
that alternatives such as home care and day care can be improved.
This use of targets is an important change from the usual technique
of extrapolating from past trends to forecast the demand for hospital
services at a future point in time. Despite the difficulties inherent
with the setting of normative hospitalization rates, noted in
Chapter II, the National Health Service established a public-policy
objective to change the system of hospital care and set hospital
building targets after comparing estimates of future need with the
policy objectives.

In the early 1960s, the Canadian government commissioned a
broad study on the state of the nation's health services (Royal
Commission on Health Services, 1964). Part of its mandate was to
report on the future need for health services. Although the Com­
mission carefully stated that it could not "predict" the future
demand for beds, it did extrapolate the 1958-61 hospitalization
experience to estimate that the 1971 demand would be 1,995 patient
days per 1,000 population for acute hospital care. The Commission
examined occupancy rates and arbitrarily increased the average
rate from 80.0% to 81.6% when expressing the demand forecast in
terms of hospital beds. The Report of the Commission states that
the forecast was only intended to indicate a "general order of magnitude of the need for physical facilities." Because of its generality, the forecast could only be used to show what might happen if past trends were to continue. In fact, the Greater Vancouver Regional Hospital District's incidence rate of hospitalization in 1971 was 1,380 patient-days/1000 persons-year, 31% below the Royal Commission's estimate of 1995/1000 for the 1971 national average. The trend in that era of increasing usage of acute-care hospitals did not in fact continue.

By the early 1960s, the United States had evaluated the performance of the Hill-Burton legislation of 1946 and found it less satisfactory than expected. Thus May (1967) states that while the legislation did expand the stock of hospital facilities, unfortunately the forecasting formula tended to entrench local patterns. Further, the area-wide planning agencies created under Hill-Burton did not have authority over all hospitals which made coordination of development difficult.

Funding for planning agencies was improved by federal legislation in 1961. To provide guidance to these agencies, the U.S. Public Health Service and the American Hospital Association published a planning manual in the same year. This publication is comprehensive in its review of factors influencing planning decisions, but continues to apply current incidence rates to future populations in order to estimate future demands, thus deserving the basic criticism of the 1946 Hill-Burton method already noted. The manual does introduce one normative variable, however, because it suggests that "desirable" medical-surgical occupancy rates should be between 85-90%.

In summary of the period from the early 1900s to the 1960s,
the techniques for forecasting the future demand for acute care hospital beds have evolved from simple specification of hospital beds per population ratios to those of complex use rates, population forecasts, and occupancy equations. The next chapter completes the review by examining current forecasting methods.
CHAPTER IV
CURRENT FORECASTING METHODS

Current methods used to forecast the future demand for acute-care-hospital beds have evolved from efforts such as those described in the previous chapter. These techniques are now usually used to justify expansion of services to meet the "needs" of growing populations and to contain the "unnecessary" growth of expensive acute hospital care - depending on the user's frame of reference. Some techniques are more complicated than others, but they all can be broken down into some set of the stages listed in Table IV.

Many refinements can be made to these basic relationships to focus on specific diseases, populations, and age groups. However, no matter how sophisticated the technique may be, fundamental difficulties remain with the use of incidence rates, population forecasts and occupancy percentages.

Before the forecast process can begin, there must be agreement on the definition of the population groups whose demands for hospital care are to be forecast. For convenience, these groups are usually organized communities with political boundaries. Hospital service areas must also be known if reasonable forecasts of demand are to be made for individual hospitals. Since the geographic boundaries of these two area types do not usually coincide, adjustments must be made in the forecast to reflect the flow of patients among the areas. These adjustments are indicated by the reference to RELEVANCE INDICES in Equation 3, and are described later in this chapter. The following examples describe the creation of population groups.
TABLE IV

EQUATIONS OF

THE STANDARD FORECASTING METHOD

1. FORECAST INCIDENCE RATE OF HOSPITALIZATION = FORECAST HOSPITAL ADMISSIONS RATE x FORECAST AVERAGE LENGTH OF STAY PER ADMISSION

Patient-Days/1000-yr. = Admissions/1000/yr. x Days per Admission

2. FORECAST GROSS TOTAL DEMAND FOR HOSPITALIZATION = FORECAST INCIDENCE RATE x FORECAST POPULATION

Patient-Days/yr. = Patient-Days /1000-yr. x Population in 1000's.

3. FORECAST NET TOTAL DEMAND FOR HOSPITALIZATION = FORECAST GROSS TOTAL x FORECAST RELEVANCE INDICES + INFLOW DEMAND

Patient-Days/yr. = Patient-Days /yr. x Proportions Patient-days/yr.

4. FORECAST AVERAGE DAILY CENSUS = FORECAST NET TOTAL DEMAND + 365

Patient-Days/day (beds) = Patient-Days/yr. x Days/yr.

5. FORECAST HOSPITAL BED REQUIREMENTS = FORECAST AVERAGE DAILY CENSUS + DESIRED OCCUPANCY PERCENTAGE

beds = beds
The province of Ontario uses a planning guide that 80% of a population group's need for hospital care should be met by local hospitals, a further 10% by district hospitals, and the remaining 10% by regional or teaching hospitals (Task Force on the Cost of Health Services 1970). These service areas must be defined before this hierarchy of care levels can be established. For example, the province of Alberta used 1971 hospital insurance data on patient-flow patterns to define the boundaries of acute-care-hospital regions (Paine and Wilson, 1974). The flow patterns were then incorporated into forecasts of bed demand for each of the population groups organized as hospital regions.

In British Columbia, regional hospital districts were arranged to coincide with the political regional districts in order to facilitate financial cost sharing. Unfortunately, these hospital regions were established for administrative convenience and do not necessarily reflect the pattern of patient flow from community to regional hospitals as do the hospital regions of Alberta. The data on patient flow patterns in B.C. are available, however, and were used by Anderson (1974) to estimate the requirements for a proposed centre to serve the referral needs in obstetrics and paediatrics for the whole province. This analysis developed a working definition of tertiary care which was used to forecast the future inflow to the proposed centre. Unfortunately, the techniques he established have not been used to analyse broader inter-regional patient flow problems.

Once the population groups have been defined by methods such as those just described, the forecasting process outlined in Table IV can be applied.

The first Equation in the standard forecasting method develops
a measure of hospital use by a specific population by multiplying a forecast of the HOSPITAL ADMISSIONS RATE by a forecast of the AVERAGE LENGTH OF STAY. This count of "patient-days" is usually expressed in terms of units of one thousand persons and time units of one year to form a use rate defined as the INCIDENCE RATE OF HOSPITALIZATION.

The forecast of this Incidence Rate at a future point in time is a fundamental step and can be done in two ways. The conventional method is to extrapolate the current rate after examining past trends and then to make adjustments for expected future developments in health care. A more refined, but no less subjective method is to first forecast the Hospital Admissions Rate for the population and then multiply this rate by the forecast Average Length of Stay per admission to yield an Incidence Rate expressed as patient-days per thousand of population.

In either method, the essential question asked is "Will past trends continue, and if not, by how much should they be altered?"

Here, a multitude of influencing factors can be considered, such as; the supply of health care personnel, the supply of hospital facilities, advances in medical technology, and patterns of organization and treatment. Nevertheless, in the end, a subjective judgement must be made as to what numerical value is to be given to the Incidence Rate. If the softness of this estimate is recognized in interpreting the results, then the final forecast can remain a useful planning tool. In many cases, however, once the quantification of subjective judgement is made, the chosen numerical value is used to produce results that suffer from spurious accuracy. A reasonable way to alert the user to this uncertainty is to specify a range involving both a minimum and a maximum rate, as is done by the state planning agencies of New York and
Illinois (Melum, 1975). Although the range is still based on subjective judgement, any unjustified implication of precision is removed.

The second Equation in the standard forecast method is the application of the FORECAST INCIDENCE RATE OF HOSPITALIZATION to a forecast of the FUTURE POPULATION to produce GROSS TOTAL DEMAND FOR HOSPITALIZATION. The subject of population forecasting is complex and will not be discussed in this examination beyond the comment that it can suffer from the same problem of spurious accuracy. The steady pattern of population growth in the years following World War II is no longer a reliable trend because birth rates, immigration and migration patterns, and economic conditions are all in a state of flux. To reflect this uncertainty, ranges should be again used. For example, a study of the hospital bed needs of Scarborough, Ontario, used three estimates of the future population (most likely, next most likely, and least most likely) as a base of alternate forecasts (Thompson, 1971). In this way, the forecast can be appropriately used to reflect different possible outcomes rather than stating a single figure and masking the inherent uncertainty in the components. Taking this approach one step further, probabilities could be assigned to each alternate forecast, which would give the policy maker an indication of the degree of risk that the chosen forecast will not be accurate.

The third Equation of the standard forecasting method converts the forecast GROSS TOTAL DEMAND of the subject population group to a forecast of the NET TOTAL DEMAND through the use of RELEVANCE INDICES that distribute the Gross Total Demands of individual sub-regional districts to other districts. This reallocation accounts for the flow of patients from their district of residence to the district where
their hospital treatment is provided. Since the geographic boundaries of the specified sub-regional districts do not usually coincide with the service areas of the individual hospitals, this flow of patients across district boundaries may significantly affect the Net Total Demand of individual districts.

For example, Table V shows a hypothetical Region with three districts; District A, District B, and District C. Each district has forecast a GROSS TOTAL DEMAND for hospital services and a flow of patient demand, expressed in patient-days, to each other district, and to districts outside the Region, labelled OUTFLOW. The proportions that distribute each district's forecast Gross Total Demand have been named RELEVANCE INDICES (Johnstone, 1971). INFLOW patient-days from outside the Region are then added to the districts' demand totals to form the NET TOTAL DEMAND forecasts.

Table 5 shows that, although District A has a forecast GROSS TOTAL DEMAND of 20,000 patient-days of hospital care, the District's hospitals are forecast to receive only 13,500 patient-days, the net result of the transfers in and out. On the other hand, District B's hospitals are forecast to receive 115,000 patient-days although that District's Gross Total Demand is only 100,000 patient-days. This flow of patient demand reflects such factors as the personal preference of the patient, geography, and the availability of services.

Relevance Indices can distribute a district's forecast Gross Total Demand either among other districts in a region, or among individual hospitals in a region. For convenience, the example in Table V has grouped the hospitals within the boundaries of a district into one unit. This grouping permits the use of a single RELEVANCE INDEX to transfer patient-days from one district to all the hospitals within
another district. However, since the objective of forecasting the demand for hospital facilities is to determine the required future size of individual hospitals, the forecast NET TOTAL DEMAND of a district must be allocated among the hospitals within that district at this point in the forecast, or after either of the next two equations.

The individual Relevance Indices must be forecast to define a patient flow pattern at a future point in time. Although the current flow pattern can be applied to a forecast of Gross Total Demand, the "will present trends continue?" question must be answered.

The fourth Equation reduces the forecast annual NET TOTAL DEMAND to a daily volume. Because the smallest unit of hospital care is assumed to be one bed used by one person for one day, the forecast average daily volume in patient days is also the forecast AVERAGE DAILY CENSUS of the hospital(s) located in the forecast area.

The fifth Equation compensates for the fact that there will be fluctuations in the daily hospital census due to the stochastic nature of demands for patient admissions to hospitals. While many hospital procedures can be scheduled, maternity cases, accident cases, and urgent illnesses occur randomly and cause fluctuations in the daily census. Most planning studies have examined hospital records and state that efficiently managed hospitals operate in the range of 75-90% average occupancy with the balance to 100% held as a reserve for peak demand occasions. Since this adjustment appears to accommodate the fluctuations, the standard forecasting method selects a DESIRED OCCUPANCY PERCENTAGE to convert AVERAGE DAILY CENSUS into a higher number of acute-care-hospital-beds that will effectively satisfy the demands on nearly all occasions. The compensation for demand fluctuation is a statistical problem that does not have a universally recognized
TABLE V
EXAMPLE OF
RELEVANCE INDICES
APPLIED TO A HYPOTHETICAL
REGION

<table>
<thead>
<tr>
<th></th>
<th>DISTRICT A</th>
<th>DISTRICT B</th>
<th>DISTRICT C</th>
</tr>
</thead>
<tbody>
<tr>
<td>FORECAST GROSS</td>
<td>20,000</td>
<td>100,000</td>
<td>50,000</td>
</tr>
<tr>
<td>TOTAL DEMAND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Patient-Days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RELEVANCE INDICES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To A:</td>
<td>0.40</td>
<td>0.00</td>
<td>0.08</td>
</tr>
<tr>
<td>To B:</td>
<td>0.40</td>
<td>0.90</td>
<td>0.30</td>
</tr>
<tr>
<td>To C:</td>
<td>0.15</td>
<td>0.09</td>
<td>0.60</td>
</tr>
<tr>
<td>OUTFLOW</td>
<td>0.05</td>
<td>0.01</td>
<td>0.02</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>TRANSFER:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(PATIENT-DAYS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>From A:</td>
<td>8,000</td>
<td>8,000</td>
<td>3,000</td>
</tr>
<tr>
<td>From B:</td>
<td>0</td>
<td>90,000</td>
<td>9,000</td>
</tr>
<tr>
<td>From C:</td>
<td>5,000</td>
<td>15,000</td>
<td>30,000</td>
</tr>
<tr>
<td>INFLOW:</td>
<td>500</td>
<td>2,000</td>
<td>1,000</td>
</tr>
<tr>
<td>FORECAST NET</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL DEMAND</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(PATIENT-DAYS)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>13,500</td>
<td>115,000</td>
<td>43,000</td>
</tr>
</tbody>
</table>
solution. The selection of a DESIRED OCCUPANCY PERCENTAGE is convenient because it can be linked to past experience but it is still based on value judgements which differ from one planner to another. Because the distinction between operating efficiency and bed-capacity efficiency is not clear, the significance of occupancy percentages can be deceptive. Low occupancy can result from either an inefficient operation or from an oversupply of beds; the reverse applies to high occupancy. Forecasts that use fixed occupancy rates seldom discuss the basis of the choice other than to state that, "Informed and experienced judgement seems to be the best option presently available for deciding upon desirable occupancy rates" (Martin, 1975).

The problem can be approached from another angle by changing the focus of the forecast from the population as a whole to the individual hospital. Using the forecast average daily census as the base size of a hospital, statistical theory can be used to determine the operating size that will accommodate most of the demand fluctuation. Blumberg (1961) states that the Poisson distribution may describe the fluctuations in the demand for hospital facilities if there are no serious bed shortages. Using this distribution, the standard deviation is precisely the square root of the mean, which is the average daily census in this case. Since the probability that the demand fluctuations will not exceed the mean plus three standard deviations is sufficiently high, i.e., 0.997, the desired hospital bed count can be determined by the following formula:

\[
\text{FORECAST HOSPITAL BED REQUIREMENT} = \frac{\text{FORECAST AVERAGE DAILY CENSUS}}{\text{AVERAGE DAILY CENSUS}} + 3 \sqrt{\frac{\text{FORECAST AVERAGE DAILY CENSUS}}{\text{AVERAGE DAILY CENSUS}}}
\]

This method accommodates the reality that small hospitals exper-
ience wider demand fluctuations that do large hospitals. Thus, in order to accommodate the peak periods, small hospitals must have a larger proportional bed reserve, which in turn will lower their average occupancy percentage. For example, an arbitrary average 90% occupancy percentage may not then be realistic for a 75 bed hospital.

Table VI illustrates the relationship between the forecast AVERAGE DAILY CENSUS and the DESIRED HOSPITAL BED COUNT using the Poisson method.

<table>
<thead>
<tr>
<th>FORECAST AVERAGE DAILY CENSUS (A.D.C.)</th>
<th>SQUARE ROOT OF A.D.C.</th>
<th>FORECAST HOSPITAL BED REQUIREMENT</th>
<th>OCCUPANCY PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1600</td>
<td>40</td>
<td>1720</td>
<td>93%</td>
</tr>
<tr>
<td>400</td>
<td>20</td>
<td>460</td>
<td>87%</td>
</tr>
<tr>
<td>100</td>
<td>10</td>
<td>130</td>
<td>77%</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>40</td>
<td>63%</td>
</tr>
</tbody>
</table>

Table VI clearly shows that smaller hospitals require a larger bed margin above the forecast Average Daily Census to accommodate random fluctuations in demand. These fluctuations force smaller hospitals to operate at occupancy percentages lower than those that can be attained by larger hospitals.

When very small hospital units are considered, the Poisson
method will indicate wide census swings and, thus, large required bed reserves. In reality, however, the hospital admissions for scheduled procedures dampen these swings, making the Poisson method inappropriate. To overcome this problem, the state planning agency of Alabama only uses the Poisson method for larger hospital units, and uses the traditional occupancy guides for smaller units (Melum, 1975).

These five Equations, noted in Table IV, summarize current methods used to forecast the GROSS TOTAL DEMAND for hospital services for a specific population group, and to transform this total into a forecast of HOSPITAL BED REQUIREMENTS for groups of hospitals or individual hospitals.
CHAPTER V
METHODOLOGY

During the summer of 1976, separate examinations of the future acute-care-bed requirements of the Greater Vancouver Regional Hospital District (G.V.R.H.D.) were being conducted by both the Regional and Provincial hospital-planning agencies. The method used by British Columbia Hospital Programs (B.C.H.P.) followed a traditional forecasting pattern as described in Chapter IV to estimate the 1981 demand for each of the nine sub-Regional districts that make up the G.V.R.H.D. However, this method did not account for intra-Regional patient flow and did not directly link a forecast of the net demands of the six sub-Regional districts that have hospitals to the proposed bed capacities of those hospitals. For these reasons, the proposed bed capacities were not unanimously accepted within the Region. In addition, there were differences of opinion on both the future population estimates and the forecast incidence rates used by B.C.H.P.

In order to discuss these differences of opinion, the G.V.R.H.D. altered the values of the input variables used by B.C.H.P. and then manually calculated alternate forecasts. The discussion of policy issues was hampered by the slow response of the manual forecasting method.

To overcome these difficulties, I developed for the G.V.R.H.D., a modification of the B.C.H.P. forecast in the form of a computer program with interchangeable data files. This enabled a quick response-time to questions about "what would happen if ...?" The B.C.H.P. forecast was straightforward in its method and it did break down the sub-Regional population groups into age classifications that had distinct
hospital use patterns. However, it did not incorporate such current techniques as the use of high and low ranges for incidence rate and population forecasts, the use of occupancy factors related to the size of individual hospitals, and, as mentioned earlier, the use of a mechanism to account for intra-regional transfers and to allocate inflow among the districts.

The computer forecasting program that I developed could have incorporated all of these techniques but would then have confused the Regional and Provincial policy makers by making them choose the "more correct" forecast. To be useful, the forecasting program had to be directly comparable to the "official" B.C.H.P. method and still provide a tool for the analysis of alternative values for the accepted variables.

The most important area of concern was a method of incorporating the intra-Regional transfers. The B.C.H.P. forecast had no such method. I decided to duplicate the B.C.H.P. method up to the forecast of the GROSS TOTAL DEMAND for each district. At this point, the GROSS DEMAND and the INFLOW to the G.V.R.H.D. were internally allocated to the Region's districts according to the current patient-flow patterns. By using this approach, the two agencies could agree on the forecast of the basic GROSS TOTAL DEMAND but debate the allocation of required facilities.

The computer forecasting program was organized so that different values of variables could be incorporated and the resulting alternate forecasts quickly produced. Examples of such alternate forecasts are described in Chapter VI.

The computer program was validated by comparing the GROSS TOTAL DEMAND totals calculated by the computer forecasting method and the B.C.H.P. method. A summary of this comparison is discussed in Chapter VI.
THE COMPUTER FORECAST COMPONENTS

The following section describes the components (variables and processes) of the computer forecasting program and their inter-relationships. These inter-relationships are shown on the fold-out flow diagram, Figure I.

DISTRICTS

The twelve municipalities and three electoral areas of the G.V.R.H.D. are organized into nine school districts. Because hospital insurance records note the school district as the patient's place of origin, these school districts can be conveniently used as the basic population groups for G.V.R.H.D. planning. These districts are listed in Table VII.

<table>
<thead>
<tr>
<th>NO.</th>
<th>SCHOOL DISTRICT</th>
<th>SUB-REGIONAL DISTRICT</th>
</tr>
</thead>
<tbody>
<tr>
<td>36</td>
<td>Surrey</td>
<td>Surrey</td>
</tr>
<tr>
<td>37</td>
<td>Delta</td>
<td>{North Delta, Ladner}</td>
</tr>
<tr>
<td>38</td>
<td>Richmond</td>
<td>Richmond</td>
</tr>
<tr>
<td>39</td>
<td>Vancouver</td>
<td>Vancouver</td>
</tr>
<tr>
<td>40</td>
<td>New Westminster</td>
<td>New Westminster</td>
</tr>
<tr>
<td>41</td>
<td>Burnaby</td>
<td>Burnaby</td>
</tr>
<tr>
<td>43</td>
<td>Coquitlam</td>
<td>Coquitlam</td>
</tr>
<tr>
<td>44</td>
<td>North Vancouver</td>
<td>}</td>
</tr>
<tr>
<td>45</td>
<td>West Vancouver</td>
<td>}</td>
</tr>
</tbody>
</table>

In most cases, the districts are reasonable geographic entities.
for hospital planning purposes. However, in this thesis, two modifications were made to better suit the population concentrations. District No. 37, Delta, has two distinct population centres, each having different relationships with neighbouring areas. Hence, North Delta with 48% of the population and Ladner with 52% were created. They each were assumed to have the same per capita experience for hospital use as for Delta as a whole. The second modification concerned Districts 44 and 45, North and West Vancouver, which are separated from the rest of the G.V.R.H.D. by water and can reasonably be considered as one entity for hospital planning purposes. The resulting combined unit, labelled "North Shore", assumed a population weighted average of the per capita hospital use experience of North and West Vancouver.

**POPULATION**

The POPULATION of each district was grouped into the classifications shown in Table VIII.

<table>
<thead>
<tr>
<th>AGE</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 14 yrs.</td>
<td>Paediatric</td>
</tr>
<tr>
<td>15 - 44 yrs. female</td>
<td>Maternity</td>
</tr>
<tr>
<td>15 - 69 yrs.</td>
<td>Adult Medical &amp; Surgical (less maternity)</td>
</tr>
<tr>
<td>70 + yrs.</td>
<td>Geriatric Medical &amp; Surgical</td>
</tr>
</tbody>
</table>

Each of these groups was considered to be a separate population having no interaction with the others. Separate regional forecasts were made for each population group and then these forecasts were summed
to produce the total Regional forecast.

**INCIDENCE RATES**

Separate INCIDENCE RATES OF HOSPITALIZATION for each population group in each district were used. I would have preferred to use separate forecasts of HOSPITAL ADMISSION RATES per 1000 population and AVERAGE LENGTHS OF STAY to determine the INCIDENCE RATES as shown by the dotted lines in Figure 1. However, to ensure that the two forecasts would be as similar as possible in format, I used the B.C.H.P. INCIDENCE RATES.

**GROSS DEMAND**

The POPULATION of each district age group was multiplied by its corresponding forecast INCIDENCE RATE to produce the GROSS DEMAND for hospitalization expressed in patient-days per year by district.

**TRANSFER MATRIX**

The GROSS DEMAND for each district was distributed among the other G.V.R.H.D. districts and outside the Region by multiplying the GROSS DEMANDS by the Relevance Indices of the TRANSFER MATRIX defined below. Relevance Indices, as discussed in Chapter IV, usually reflect the proportion of a population's total hospital use that is serviced by each hospital in a region. At the time this study was undertaken, the future number and location of G.V.R.H.D. hospitals was uncertain. To avoid the problem resulting from this uncertainty, the intra-Regional referrals were transformed into a district-by-district matrix rather than a district-by-hospital matrix; that is, the Relevance Indices were for patient flows among districts of patient origin and districts of patient treatment rather than among districts of patient origin and hospitals of patient treatment.

A TRANSFER MATRIX was computed from 1975 data for each of the four age-sex groups. Table IX shows a typical TRANSFER MATRIX used in this study. The numbers in each row show, for the district of patient
### TABLE IX: TYPICAL TRANSFER MATRIX

(Paediatric Age-Sex Group)

<table>
<thead>
<tr>
<th>PATIENT ORIGIN</th>
<th>AREA OF HOSPITAL TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S</td>
</tr>
<tr>
<td>SURREY</td>
<td>.550</td>
</tr>
<tr>
<td>NORTH DELTA</td>
<td>.350</td>
</tr>
<tr>
<td>LADNER</td>
<td>.350</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>.000</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>.000</td>
</tr>
<tr>
<td>NEW WEST</td>
<td>.000</td>
</tr>
<tr>
<td>BURNABY</td>
<td>.000</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>.000</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>.000</td>
</tr>
</tbody>
</table>

**TRANSFER MATRIX ASSUMED**

**PATIENT ORIGIN**

---

**TOTAL:**

1.000
origin, the proportions of the GROSS DEMAND that are treated in the other G.V.R.H.D. districts. For example, the number .250 in the Surrey Row and "V" column, means that 25% of the district of Surrey's demand for hospital care is treated in Vancouver for this particular age group forecast. Clearly, the numbers in each row must total 1.0. The columns define the districts where the patients are treated, and consist of the same nine districts of origin plus the column "OUT", representing OUTFLOW for treatment outside the G.V.R.H.D. and thus beyond the scope of this study.

With regard to the patient-day allocations within a district, it was assumed that once the FORECAST HOSPITAL BED REQUIREMENTS of a district were determined, then the allocation of those requirements to existing and new hospitals within that district would need to be the subject of a more detailed study.

**INFLOW**

The hospitals in the G.V.R.H.D. offer Regional referral services to adjacent communities and tertiary referral services for the whole province of British Columbia. In 1975, the patient-day volume from outside the G.V.R.H.D. that was serviced by Regional hospitals was the equivalent of approximately 720 acute-care-hospital beds * or 16% of the G.V.R.H.D.'s. own patient care volume. This is a large volume and its distribution among G.V.R.H.D. hospitals is an important consideration when determining specific future requirements.

* The inflow from outside the G.V.R.H.D. was 223,402 patient days in 1975. At 85% occupancy, this is the equivalent of 720 beds. Data sources: B.C.H.P. data on magnetic tape.
For the purpose of the computer forecast, the INFLOW was stated as a percentage of the G.V.R.H.D. GROSS DEMAND in patient days; a separate percentage was used for each age-sex group.

**NET DEMAND**

After the INFLOW was determined, it was allocated among the districts according to the specified percentages. The distributed INFLOW was then added to the DISTRIBUTED GROSS DEMAND to form the NET DEMAND forecast for each district.

**AVERAGE DAILY CENSUS**

In order to convert the forecast NET DEMAND recorded in patient-days to hospital bed equivalents, the totals were divided by 365 to produce the forecast AVERAGE DAILY CENSUS.

**OCCUPANCY PERCENTAGE**

The B.C.H.P. target OCCUPANCY PERCENTAGES were used in the computer forecasting programme. I should have preferred to use the Poisson distribution method, described in Chapter IV, that varies the planned occupancy with the forecast AVERAGE DAILY CENSUS of the individual hospital. However, to avoid confusing the more important issue of the recognition of intra-Regional transfers, I adopted the B.C.H.P. policy of setting target OCCUPANCY PERCENTAGES, no matter how inappropriate they may be when applied to specific hospitals.

**FORECAST HOSPITAL BED REQUIREMENTS**

The forecast AVERAGE DAILY CENSUS was divided by its corresponding OCCUPANCY PERCENTAGE to produce the FORECAST HOSPITAL BED REQUIREMENTS for each age-sex group of each district.

**BALANCE OF BEDS REQUIRED**

The program was extended by a simple step to compare the FORECAST HOSPITAL BED REQUIREMENTS with the bed totals proposed by B.C.H.P. for
the target date, in this case, 1981. This comparison produced the BALANCE OF BEDS REQUIRED to meet the forecast. If the FORECAST HOSPITAL BED REQUIREMENTS are adopted as targets, this calculation provides the policy analysts with the incremental changes necessary to modify the proposed bed totals to match the forecast requirements of the districts.
CHAPTER VI
EXPERIMENTAL PROCEDURES

FORECAST PROCEDURE

The structure of the forecasting process was translated into a computer program using the BASIC language. A copy of the program is attached as Appendix A. It was designed from the sequential steps suggested in the other current forecasting methods noted in Chapter IV, and the forecast produced by B.C.H.P. The forecasting program was designed for use on a time-sharing computer facility with input through cathode-ray-tube terminals and output from either the terminals or printers.

In order to offer maximum flexibility in producing forecasts for policy analysis, the files containing the values of the program variables are external to the forecast program. This allows the user to create a specific forecast from any selected data sets. In addition, the program can be run for one or more age-sex group forecasts with the option of combining the separate runs into a summary forecast. A series of instructions appear on the terminal screen and lead the user through the process interactively. Users can operate the program without having to know the details of either its internal processes or the links to the data files, but the user must know the names of the data files because they are required as inputs to allow the program to function.

The program output displays in tabular form both the values initially specified by the user for the program variables, and the comparison between the required and planned hospital beds for those districts which contain hospitals. The districts are then regrouped to four geographic areas and the comparison is repeated. This information is produced for
each run; a run consists of a forecast for one age-sex group or a summary of two or more age-sex-group forecasts.

DATA

The computer forecasting program was created to explore alternatives to the B.C.H.P. forecast, and to facilitate the resolution of differences of opinion on policy issues. Thus, it was necessary to avoid disagreements about the method used in the computer program since such disagreements would have pre-empted worthwhile discussion about the G.V.R.H.D.'s contention that the B.C.H.P. planning proposal was not appropriate because it didn't recognize intra-Regional patient transfers. In order to avoid such disagreements, the structure of the computer program was based on the B.C.H.P. forecast, as were the primary input data. The computer program could then be used to provide alternate forecasts for the examination of policy options by altering the input data.

POPULATION

In the autumn of 1976, there was considerable debate over the projections of the G.V.R.H.D. population. The preliminary release of the 1976 Statistics Canada census showed that the previously rapid growth of the G.V.R.H.D. had severely slowed. These results made earlier 1981 population projections appear unrealistic. Consequently, B.C.H.P. adjusted their 1981 population projections of the nine G.V.R.H.D. school districts and used past census data to estimate the division of these totals into the four age-sex groups. The forecasts of the districts' total population were rounded to the nearest thousand, but, for some unexplained reason, the age-sex-group forecasts appeared accurate to one digit. This was not reasonable in light of the tentative nature of the
original forecast. To improve on this, I rounded the data as closely as possible to the nearest 50 persons without substantially shifting the mix of the age groups or altering the total forecast for each district.

**INCIDENCE RATES**

The Incidence Rates of Hospitalization were used directly from the B.C.H.P. forecast. The Provincial planners had examined the general decline in hospitalization and judged that the trend would continue to 1981. Their estimate was also influenced by the government's adopted policy of strengthening the delivery of extended and intermediate care and reducing the inappropriate use of acute-care-hospital facilities. This planned reduction in acute care hospitalization was not specifically justified by a quantitative relation, but it was implicitly included in the forecast incidence rates.

These two data sets were the primary base used to forecast the Gross Demand for hospitalization for each of the districts by age-sex group. Up to this point, the two forecasts produced essentially identical results, with any differences being due to the rounding of the population totals for individual age-sex groups.

**TRANSFER MATRIX**

The data used to produce the transfer matrix did not come directly from the B.C.H.P. forecast because this component of the computer program was an addition to the Provincial method. B.C.H.P. has for several years produced data on the source and destination of G.V.R.H.D. hospital patients. This information is compiled from hospital-insurance data and made available to the Region, but is not published. As of December 1976, the latest compiled information from B.C.H.P. was based on 1974 data. The basic 1975
data tapes were in use at the University of British Columbia and special arrangements were made through the Division of Health Services, Research and Development* to extract the data on intra-G.V.R.H.D. patient transfers in a form consistent with the B.C.H.P. format. The data was processed using routines contained in the Statistical Package for the Social Sciences (S.P.S.S.) available at the U.B.C. Computing Centre.

The patient transfer data, in patient days, was organized to show matrices of district of patient origin (9) by hospital of patient treatment (17), for each age-sex group. These matrices were converted manually into Transfer Matrices of Relevance Indices showing district of patient origin (9) by district of patient treatment (9 + 1 for outflow). These indices were initially computed to three places of decimal for 1975 data.

To make the Relevance Indices consistent with the uncertainty of the data used in the earlier portion of the forecast, the use of accuracy to the third decimal-place had to be changed because it gave a false implication of precision. A Relevance Index with an implied accuracy to .001 cannot legitimately be applied to a patient day total format derived from a population estimate rounded to the nearest 1000 persons. To resolve this problem, the Relevance Indices were first rounded to the nearest 1% and then to the nearest 5% to test the sensitivity of the computations to such changes. The rounding to the nearest 5% produced results that only varied from the base results by approximately 1%; this variation was considered acceptable in attaining an internal-data consistency for the computer forecasting program.

The future allocation of patients to Regional hospitals was a highly controversial subject since it could affect the operating size of each

*Division of Health Services, Research and Development Co-ordinator's Office, Health Sciences Centre, U.B.C. Vancouver, B.C.
hospital. In order to study the effects of alternate policies, I ran the computer forecasting program with an alternate Transfer Matrix to reflect an alternate bed distribution policy. This analysis is described later in this chapter. The 1975 pattern of patient referrals within the G.V.R.H.D. was used as the 1981 Transfer Matrix for the Standard Forecast produced by the computer program. This was done to introduce the concept of the Transfer Matrix with minimal controversy; the "if present trends continue" approach.

**INFLOW**

The B.C.H.P. forecast accounted for the Inflow of patients into the G.V.R.H.D. by subtracting the Outflow from the Inflow to create a net Inflow expressed as a percentage of the total G.V.R.H.D. hospital usage. B.C.H.P. studied the historical pattern of net Inflow to the G.V.R.H.D. before the 1981 rate was forecast. Because the Transfer Matrix of the computer program incorporates the Outflow, it was decided to separate Inflow from Outflow rather than use the B.C.H.P. composite Inflow rate.

The data on the Inflow of patients into the G.V.R.H.D. and on their distribution among the Region's hospitals was obtained from the analysis that produced the Transfer Matrix. For the purpose of forecasting the Net Demand for hospital services in the G.V.R.H.D., the Inflow to the G.V.R.H.D. should be related to the Gross Demand of the British Columbia population outside the G.V.R.H.D., the source of the Inflow to the Region. However, since a population forecast, consistent with the one used for the G.V.R.H.D., was not available for the rest of the province, I decided to relate the Inflow to the Gross Demand of the G.V.R.H.D. as a second-best method. This convenience produces results just as acceptable as the more theoretically correct method since it is reasonable to assume that
the Gross Demand of the B.C. population outside of the G.V.R.H.D. will be subject to the same influence as the Gross Demand of the G.V.R.H.D. and thus will fluctuate similarly to the Gross Demand of the G.V.R.H.D.

The actual 1975 Inflow in patient-days for each age-sex group was expressed as a percentage of the total 1975 Gross Demand of that age-sex group. These percentages were then used in the forecasting program to produce forecast Inflow. The distribution of the total inflow among the Region's districts was expressed as proportions of the total Inflow in the Inflow Transfer Vector. For example, New Westminster received .05 of the total referrals in the adult age-sex group (ages 15-69) in 1975.

In order to avoid spurious accuracy, and to be consistent with the previous use of 1975 data, the Inflow percentages and the Inflow Transfer Vector's percentages were rounded. Since a 2 - 3% change in the Inflow percentages caused significant absolute changes in the forecast Inflow patient-days, the Inflow percentages were rounded to the nearest 1%. Because such changes to the Inflow Transfer Vector's percentages did not produce significant absolute changes in the distribution of Inflow patient-days, the percentages were rounded to the nearest 5%, consistent with the Transfer Matrix Relevance Indices.

**Occupancy Percentages**

The Occupancy Percentages used to transform the Net Demand in patient-days by district to Forecast Hospital Bed Requirements were those used by B.C.H.P.: 80% for maternity, 85% for paediatrics, and 90% for adult. The reason for this choice has been discussed in Chapter V.

**Planned Beds**

The final data set used in the computerized forecasting program
is the sum of the hospital beds serving each age group that is planned for each district by 1981. These totals were obtained from an unpublished B.C.H.P. working paper entitled "Review of the 1981 Bed Matrix". Any other proposal could have been incorporated since it is only used by the program as a benchmark for comparison with the G.V.R.H.D. forecast bed requirements. However, since part of the objective of this thesis was to compare the results of the two forecasting techniques using the same basic data and the same basic method except for the addition of the transfer matrix in the computer forecasting program, the use of the B.C.H.P. proposal was appropriate.

VERIFICATION

The computer forecasting program was validated by producing a test forecast using a neutral\textsuperscript{*} Transfer Matrix and then comparing the forecast of NET DEMAND patient-days for each age-sex group of each district with the equivalent B.C.H.P. forecast. A selection of the results is listed in Table X.

Since both the forecasts use the same data, the comparison should show absolutely no variation. There is slight variation in the results that is caused by the rounding of the B.C.H.P. population forecast totals. The reasons for this rounding have been noted in Chapter V. The validation process confirmed that the computer program contained the same initial structure as does the B.C.H.P. forecast and that the complexity of the structure created in the computer program to accommodate intra-Regional patient transfers had not contaminated the calculation sequence.

\textsuperscript{*}The Neutral Transfer Matrix had values of 1.0 on the main diagonal to correspond with the fact that the B.C.H.P. forecast has no matrix.
TABLE X


<table>
<thead>
<tr>
<th>PAEDIATRIC AGE GROUP</th>
<th>TOTAL POPULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>BCHP</td>
</tr>
<tr>
<td>Surrey</td>
<td>15,345</td>
</tr>
<tr>
<td>Delta</td>
<td>9,030</td>
</tr>
<tr>
<td>Richmond</td>
<td>8,293</td>
</tr>
<tr>
<td>Vancouver</td>
<td>27,000</td>
</tr>
<tr>
<td>New West.</td>
<td>3,093</td>
</tr>
<tr>
<td>Burnaby</td>
<td>11,025</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>10,605</td>
</tr>
<tr>
<td>North Shore</td>
<td>9,608</td>
</tr>
<tr>
<td>Total</td>
<td>93,999</td>
</tr>
</tbody>
</table>
The B.C.H.P. forecast was made from the interaction of many variables such as population, age group and incidence rate. It is true that any change in input variables could be manually traced through the maze of calculations to explain the interactions, but, considering the number of changes possible, such a procedure would be impractical. The introduction of a Transfer Matrix would have made the interaction even more complex if calculated manually. The computerization of the forecast made it feasible to study the effect on the final FORECAST OF HOSPITAL BED REQUIREMENTS of a change in the value of any one of the variables.

Since the computerized forecasting program incorporates non-linear relations, any given input change in the value of a variable does not necessarily produce a proportional change in a given output forecast. For example, since the age mix varies among the districts as do the incidence rates of hospitalization, an equal proportional change in each district to the value of either, or both of these variables would produce disproportionate changes in the net demand for hospital services in each district because of the non-linear relations introduced by the Transfer Matrix.

In order to examine this aspect of the forecast program, several controlled changes made to the input data were compared with the corresponding changes produced in the output forecast. This experiment was called a SENSITIVITY ANALYSIS. The six primary variables (population, incidence rate, inflow, distribution of inflow, transfers, and occupancy percentage) could produce an unmanageable set of interactions if a full sensitivity study were undertaken. It was decided to restrict the analysis to the two most controversial variables: population and incidence
The B.C.H.P. forecasts of the G.V.R.H.D. population's rate of growth, its age distribution, and its geographic distribution were based on both the preliminary federal census and on past distributions. However, without the benefit of a detailed census, the G.V.R.H.D. believed that there was little likelihood that the forecasts would be accurate.

The B.C.H.P. forecasts of Incidence Rates of Hospitalization were based partly on the assumption that alternate facilities to acute care would be available to reduce the acute-care Incidence Rates. There was some doubt when the forecast was discussed in 1976 whether these alternate facilities really would be available and, therefore, some doubt whether the lower Incidence Rates could be achieved.

Since there was no consensus on the values of these variables, the computer forecasting program was used to explore how sensitive the forecasting process was to changes in the values of the Population and Incidence Rate of Hospitalization variables.

First, the possibility of the geriatric age group (70+ years) rising to 10% of the total population was considered. Since the Incidence Rate projected for that group is almost four times the regular adult rate, such a change would be expected to reveal any unexpected results from obscure interactions. Secondly, a change in the Incidence Rate for this age group also would be expected to reveal unexpected sensitivities.

Table XI outlines the eight runs that were made to analyse the sensitivity of the computer forecasting technique.

**RUN ONE:** This run was used as the standard for the analysis since it contained the base data from the B.C.H.P. 1981 forecast with the addition of 1975 transfer and inflow data.
TABLE XI
INPUT CHANGES MADE FOR THE SENSITIVITY ANALYSIS

<table>
<thead>
<tr>
<th>RUN</th>
<th>AGE GROUP</th>
<th>POPULATIONS</th>
<th>INCIDENCE RATES</th>
</tr>
</thead>
<tbody>
<tr>
<td>ONE</td>
<td>GERIATRIC</td>
<td>STANDARD</td>
<td>STANDARD</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>STANDARD</td>
<td>STANDARD</td>
</tr>
<tr>
<td>TWO</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>STANDARD</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>STANDARD</td>
</tr>
<tr>
<td>THREE</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>-10%</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>STANDARD</td>
</tr>
<tr>
<td>FOUR</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>STANDARD</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>-10%</td>
</tr>
<tr>
<td>FIVE</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>-10%</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>-10%</td>
</tr>
<tr>
<td>SIX</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>+10%</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>STANDARD</td>
</tr>
<tr>
<td>SEVEN</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>STANDARD</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>+10%</td>
</tr>
<tr>
<td>EIGHT</td>
<td>GERIATRIC</td>
<td>PLUS 64%</td>
<td>+10%</td>
</tr>
<tr>
<td></td>
<td>ADULT</td>
<td>MINUS GERIATRIC INCREASE</td>
<td>+10%</td>
</tr>
</tbody>
</table>
RUN TWO: In this run, the percentage of the geriatric age group was increased from approximately 6% to 10% of the total G.V.R.H.D. population; an increase of approximately 64%. This change brought the total G.V.R.H.D. geriatric population from 69,175 to 113,500. The existing age-group ratios vary among districts and, unfortunately, it was not possible to estimate how these ratios would vary from each other in the future, therefore, proportional changes, rather than absolute changes were made to the geriatric populations of each district, that is, the geriatric population of each district was increased by 64%. In turn, this meant that the adult population in any given district was decreased by an amount equal to the geriatric population increase so that the combined adult-geriatric population group remained constant in total. This population shift was retained in each of the following sensitivity runs. All other variables had standard values.

RUN THREE: The incidence rates of the geriatric population group in each district were decreased by 10%, while the adult incidence rates remained at standard levels.

RUN FOUR: The incidence rates of the adult population group in each district was decreased by 10% while the geriatric incidence rates remained at standard levels.

RUN FIVE: The incidence rates of both the geriatric and the adult population groups in each district were decreased by 10%.

RUN SIX: The incidence rate for the geriatric population in each district group was increased by 10%, while the adult incidence rates remained at standard levels.

RUN SEVEN: The incidence rates of the adult population group in each district were increased by 10%, while the geriatric incidence rates remained at standard levels.
RUN EIGHT: The incidence rate of both the geriatric and adult population groups in each district were increased by 10%.

THE POLICY ANALYSIS

The Provincial Ministry of Health and the Greater Vancouver Regional Hospital District share in the costs of hospital construction within the G.V.R.H.D. The agencies, therefore, have assumed a mandate from their electorates to ensure that the most effective changes in hospital service result from the expenditure of public funds for hospital construction. In order to forecast the expenditures required for hospital construction, these two agencies must agree on the future values of the variables used in the forecast of the demand for hospital services. However, all of these variables can be influenced, to some degree, by policy decisions. For example, future POPULATION totals can be influenced by immigration policies, by economic policies and by urban-planning policies; future RELEVANCE INDICES can be influenced by geographic shifts in population, by hospital operating policies and by hospital construction policies.

To effectively discharge their mandate, the funding agencies must analyse the effects of alternate policy positions. The computer forecasting program, described in Chapter V, was designed to readily accept alternate input data so that alternate FORECASTS of HOSPITAL BED REQUIREMENTS can be used to study the effects of the alternate policy positions that the data reflect.

The following sections describe the alternate policy positions which were analysed by comparing the corresponding forecast produced by the computer forecasting program to the Standard Forecast.
A. POPULATION

During the summer of 1976, the G.V.R.H.D. was forecasting a 1981 Population of the Region of 1,322,000 persons, a total which proved to be 16% higher than the B.C.H.P. forecast which was made later in the year based upon the interim results of the 1976 federal census. Since the G.V.R.H.D. questioned the accuracy of the 1976 federal census and, thus, the B.C.H.P. population forecast for 1981, the computer forecasting program was used to analyse the effects of a 10% increase in the B.C.H.P. population forecast for 1981. Table XII shows the details of this increase.

B. INCIDENCE RATES OF HOSPITALIZATION

The B.C.H.P. forecast of the 1981 G.V.R.H.D. Incidence Rates of Hospitalization was based on the assumption that alternative levels of care will "soon" be available, and thus, the acute-care Incidence Rates should fall. Since the G.V.R.H.D. questioned this assumption, the computer forecasting program was used to analyse the effects of a 10% increase in the 1981 Incidence Rates of Hospitalization for each age-sex group in each district as forecast by B.C.H.P. Table XIII lists the overall increase by district. The increased Incidence Rates listed were calculated by the program by dividing the increased Total Gross Demand, in patient-days, of each district by that district's population. Because of this calculation, the increased Incidence Rates listed are not exactly 110% of the Standard Rates, because of rounding errors.

C. INFLOW

The G.V.R.H.D's. Inflow (patient-days) expressed as a percentage of the Gross Demand was assumed to remain constant to 1981; that is, remain equal to the 1975 percentage. However, the G.V.R.H.D. was aware that this
TABLE XII

1981 FORECAST

G.V.R.H.D. POPULATION TOTALS

AT 110% OF 1981

STANDARD POPULATION FORECAST

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>STANDARD FORECAST</th>
<th>110% STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>145,000</td>
<td>159,500</td>
</tr>
<tr>
<td>NORTH DELTA</td>
<td>36,000</td>
<td>39,600</td>
</tr>
<tr>
<td>LADNER</td>
<td>39,000</td>
<td>42,900</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>90,000</td>
<td>99,000</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>400,000</td>
<td>440,000</td>
</tr>
<tr>
<td>NEW WESTMINSTER</td>
<td>37,000</td>
<td>40,700</td>
</tr>
<tr>
<td>BURNABY</td>
<td>140,000</td>
<td>154,000</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>103,000</td>
<td>113,300</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>145,000</td>
<td>159,500</td>
</tr>
</tbody>
</table>

TOTAL 1,135,000 1,248,500
TABLE XIII

1981 FORECAST

G.V.R.H.D. INCIDENCE

RATES OF HOSPITALIZATION

(PATIENT-DAYS/1000 POPULATION-YEAR)

AT 110% of 1981

STANDARD INCIDENCE

RATES FORECAST

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>STANDARD FORECAST</th>
<th>110% STANDARD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>1281</td>
<td>1410</td>
</tr>
<tr>
<td>NORTH DELTA</td>
<td>825</td>
<td>909</td>
</tr>
<tr>
<td>LADNER</td>
<td>823</td>
<td>907</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>978</td>
<td>1076</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>1623</td>
<td>1786</td>
</tr>
<tr>
<td>NEW WESTMINSTER</td>
<td>1553</td>
<td>1709</td>
</tr>
<tr>
<td>BURNABY</td>
<td>1094</td>
<td>1204</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>901</td>
<td>991</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>1090</td>
<td>1199</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1274</strong></td>
<td><strong>1402</strong></td>
</tr>
</tbody>
</table>
Inflow percentage may fall as a result of the construction of more specialized hospital facilities outside the Region.

The effects of this hospital construction policy were analysed by reducing the G.V.R.H.D's. Inflow percentage by 10.0%. For example, the adult Inflow percentage of 19.0% was reduced by 10.0% to form an alternative Inflow percentage of 17.1%. When this percentage was applied to the Adult Gross Demand in the Standard Forecast of 895,830 patient-days, the Inflow decreased from 170,208 to 153,187 patient-days, a reduction of 10%. Table XIV lists the standard and the alternative Inflow percentages.

### Table XIV

<table>
<thead>
<tr>
<th>AGE-SEX GROUP</th>
<th>STANDARD INFLOW PERCENTAGE</th>
<th>ALTERNATE INFLOW PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAEDIATRIC</td>
<td>38.0</td>
<td>34.2</td>
</tr>
<tr>
<td>MATERNITY</td>
<td>8.0</td>
<td>7.2</td>
</tr>
<tr>
<td>ADULT</td>
<td>19.0</td>
<td>17.1</td>
</tr>
<tr>
<td>GERIATRIC</td>
<td>7.0</td>
<td>6.3</td>
</tr>
</tbody>
</table>

* See the Standard Forecast in Appendix B.
The Inflow Transfer Vector that distributes the annual Inflow patient-days among the districts of the G.V.R.H.D. was not altered to analyse the effects of an alternate Inflow distribution policy because the Inflow is currently distributed to specialized facilities and no change in these facilities is contemplated.

D. TRANSFER MATRIX

The Transfer Matrix used by the computer forecasting program to produce the Standard Forecast, reflects the 1975 pattern of intra-G.V.R.H.D. patient transfers. The use of this pattern in the forecast process means that the pattern is not expected to change.

However, as the G.V.R.H.D's population shifts towards the suburban districts, it is reasonable to assume that a greater proportion of these districts' annual Gross Demands for hospital services should be accommodated by hospitals within these districts. The computer forecasting program was used to analyse the effect of the alternate policy that 80% of a district's annual Gross Demands for acute-care hospital services is to be accommodated by the district's own hospitals, with a further 10% to be transferred to more specialized regional referral hospitals, and with the remaining 10% to be transferred to the tertiary-care services provided by designated hospitals in Vancouver.

Table XV displays the Transfer Matrix which was used to reflect this alternate policy. The 80-10-10 policy was adapted to fit the following characteristics of the G.V.R.H.D.:

1. **SURREY** 80% of Gross Demand retained in Surrey with 10% to the nearest regional referral hospital, in New Westminster, and 10% to the tertiary care hospitals in
### TABLE XV: THE ALTERNATE TRANSFER MATRIX

<table>
<thead>
<tr>
<th>PATIENT ORIGIN</th>
<th>AREA OF HOSPITAL TREATMENT</th>
<th>$S$</th>
<th>$ND$</th>
<th>$L$</th>
<th>$R$</th>
<th>$V$</th>
<th>$NW$</th>
<th>$B$</th>
<th>$C$</th>
<th>$NS$</th>
<th>$OUT$</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td></td>
<td>.800</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.100</td>
<td>.100</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>NORTH DELTA</td>
<td></td>
<td>.800</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.100</td>
<td>.100</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>LADNER</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.800</td>
<td>.000</td>
<td>.200</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>RICHMOND</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.800</td>
<td>.200</td>
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<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.950</td>
<td>.050</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>NEW WEST</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.100</td>
<td>.900</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>BURNABY</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.150</td>
<td>.150</td>
<td>.700</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.100</td>
<td>.100</td>
<td>.000</td>
<td>.800</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td></td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.200</td>
<td>.000</td>
<td>.000</td>
<td>.000</td>
<td>.800</td>
<td>.000</td>
<td>.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>
2. **NORTH DELTA** North Delta is adjacent to Surrey's hospital and thus, was given the same pattern as Surrey.

3. **LADNER** 80% retained in Ladner with both the 10% regional and 10% tertiary transfers to Vancouver.

4. **RICHMOND** 80% retained in Richmond with both the 10% regional and 10% tertiary transfers to Vancouver.

5. **VANCOUVER** 5% of Vancouver's Gross Demand to Burnaby because Burnaby's hospital is on the boundary between these two districts. The remaining 95% to remain in Vancouver.

6. **NEW WESTMINSTER** 90% retained in New Westminster because of the location there of a regional referral hospital. 10% to Vancouver.

7. **BURNABY** 70% retained in Burnaby and 5% each to Vancouver and New Westminster because of Burnaby's adjacency to nearby hospitals. A further 10% to the regional referral hospital in New Westminster. A further 10% to tertiary care hospitals in Vancouver.

8. **COQUITLAM** 80% retained in Coquitlam with 10% to New Westminster and 10% to Vancouver.

9. **NORTH SHORE** 80% retained in the North Shore with 10% each to the regional and tertiary hospitals in Vancouver.

E. **OCCUPANCY PERCENTAGE**

The B.C.H.P. forecast used "target" percentages for each age-sex group to compensate for fluctuations in the demand for hospital admissions. As described in Chapter IV, a method using the Poisson distribution can be used to account for the relationship between the size of the individual
hospital's forecast Average Daily Census and the expected range of demand fluctuations.

To analyse the effects of using this approach, rather than the "target" occupancy percentage approach, the forecast Average Daily Census for each district was pro-rated to each of the district's hospitals on the basis of existing hospital bed capacities. From this base, the forecast Hospital-Bed Requirement for each hospital was calculated using the following formula:

\[
\text{FORECAST HOSPITAL-BED REQUIREMENT} = \text{FORECAST AVERAGE DAILY CENSUS} + 3 \sqrt{\text{AVERAGE DAILY CENSUS}}
\]

These Forecast Hospital-Bed Requirements were grouped by district and then compared to the corresponding totals in the Standard Forecast.

The following Chapter gives the results of THE STANDARD FORECAST, THE SENSITIVITY ANALYSIS and THE POLICY ANALYSIS discussed in this Chapter.
CHAPTER VII

RESULTS

THE STANDARD FORECAST

The computer forecasting program was loaded with data described in Chapter VI and produced the STANDARD FORECAST; a copy of this output forecast is attached as Appendix B. Tables XVI to XIX show the comparison between B.C.H.P's. planning proposal (labelled PLANNED BEDS) and the Standard Forecast produced by the computer forecasting program (labelled G.V.R.H.D's. NEEDED BEDS) with the Standard Forecast as the base. This comparison is made for each of the following age-sex groups: Paediatric, Maternity, All Adult, and Total. The Adult (ages 15-69) and Geriatric (age 70 +) groups were combined for this comparison because the B.C.H.P. method does not differentiate Geriatric acute-care hospital beds from other Adult beds in the final proposal. Note, however, that their requirements are treated separately during the forecast.
<table>
<thead>
<tr>
<th>AREA (DISTRICT)</th>
<th>B.C.H.P's. PLANNED BEDS</th>
<th>G.V.R.H.D's. NEEDED BEDS</th>
<th>BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>44</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>LADNER</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>26</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>200</td>
<td>254</td>
<td>-54</td>
</tr>
<tr>
<td>NEW WESTMINSTER</td>
<td>55</td>
<td>51</td>
<td>4</td>
</tr>
<tr>
<td>BURNABY</td>
<td>37</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>24</td>
<td>26</td>
<td>-2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>386</strong></td>
<td><strong>417</strong></td>
<td><strong>-31</strong></td>
</tr>
</tbody>
</table>
TABLE XVII

COMPARISON BETWEEN
B.C.H.P. AND G.V.R.H.D. FORECASTS
OF 1981 G.V.R.H.D. REQUIREMENTS FOR
MATERNITY ACUTE-CARE BEDS

<table>
<thead>
<tr>
<th>AREA (DISTRICT)</th>
<th>B.C.H.P's. PLANNED BEDS</th>
<th>G.V.R.H.D's. NEEDED BEDS</th>
<th>BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>50</td>
<td>41</td>
<td>9</td>
</tr>
<tr>
<td>LADNER</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>30</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>120</td>
<td>140</td>
<td>-20</td>
</tr>
<tr>
<td>NEW WESTMINSTER</td>
<td>40</td>
<td>46</td>
<td>-6</td>
</tr>
<tr>
<td>BURNABY</td>
<td>25</td>
<td>26</td>
<td>1</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>32</td>
<td>34</td>
<td>-2</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>297</strong></td>
<td><strong>312</strong></td>
<td><strong>-15</strong></td>
</tr>
</tbody>
</table>
## TABLE XVIII


<table>
<thead>
<tr>
<th>AREA</th>
<th>B.C.H.P's.</th>
<th>G.V.R.H.D's.</th>
<th>BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PLANNED BEDS</td>
<td>NEEDED BEDS</td>
<td></td>
</tr>
<tr>
<td>Surrey</td>
<td>322</td>
<td>391</td>
<td>-69</td>
</tr>
<tr>
<td>Ladner</td>
<td>75</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>Richmond</td>
<td>173</td>
<td>133</td>
<td>40</td>
</tr>
<tr>
<td>Vancouver</td>
<td>2,616</td>
<td>2,705</td>
<td>-89</td>
</tr>
<tr>
<td>New Westmin</td>
<td>573</td>
<td>566</td>
<td>7</td>
</tr>
<tr>
<td>Burnaby</td>
<td>360</td>
<td>251</td>
<td>109</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>75</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>North Shore</td>
<td>400</td>
<td>408</td>
<td>-8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4,594</strong></td>
<td><strong>4,454</strong></td>
<td><strong>140</strong></td>
</tr>
</tbody>
</table>
### TABLE XIX


<table>
<thead>
<tr>
<th>AREA (DISTRICT)</th>
<th>B.C.H.P's PLANNED BEDS</th>
<th>G.V.R.H.D's. NEEDED BEDS</th>
<th>BALANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>416</td>
<td>475</td>
<td>-59</td>
</tr>
<tr>
<td>LADNER</td>
<td>75</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>229</td>
<td>172</td>
<td>57</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>2,936</td>
<td>3,099</td>
<td>-163</td>
</tr>
<tr>
<td>NEW WESTMINSTER</td>
<td>668</td>
<td>663</td>
<td>5</td>
</tr>
<tr>
<td>BURNABY</td>
<td>422</td>
<td>306</td>
<td>116</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>75</td>
<td>0</td>
<td>75</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>456</td>
<td>468</td>
<td>-12</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,277</strong></td>
<td><strong>5,183</strong></td>
<td><strong>94</strong></td>
</tr>
</tbody>
</table>
THE SENSITIVITY ANALYSIS

The eight computer runs described in Chapter VI provided a database on changes in the forecast NET DEMAND which the computer program produced in response to changes made from the standard adult-geriatric population mixes and incidence rates. Since the separate paediatric and maternity forecasts were not affected by these data alterations, they were excluded from the sensitivity analysis.

A. SENSITIVITY TO POPULATION CHANGES

Runs 1 and 2 were compared to determine the "sensitivity" in the NET DEMAND (in patient-days) of the combined district adult-geriatric age groups, to increases in the percentages of elderly people related to the total adult population groups in each district. Table XX summarizes this comparison and lists the "sensitivity" defined as the percentage change in NET DEMAND for each 1% increase in the geriatric population percentage of the total adult group. Note that this definition is used for convenience in understanding the significance for the NET DEMAND of an increase in the percentage of total population that is geriatric; for example, from 6 to 7%. This "sensitivity" is not the same as the formal Sensitivity which is defined as the percentage change in OUTPUT (in this case, NET DEMAND) resulting from a one percent change in INPUT (in this case, absolute POPULATION totals).

B. SENSITIVITY TO INCIDENCE RATE CHANGES

1. Runs 2 and 3 were compared to determine the percentage change in the NET DEMAND (in patient days) of the combined adult-geriatric age groups by district that resulted from a 10% decrease in the geriatric incidence rates while the adult incidence rates were held constant. Table XXI summarizes this comparison and includes a listing of the sensitivity of
NET DEMAND by district to a 1% decrease in the geriatric incidence rates.

2. Runs 2 and 5 were compared to determine the percentage change in the NET DEMAND that resulted from a 10% increase in the geriatric incidence rates while the adult rates were held constant. The calculated sensitivities were identical to those in the previous analysis, B-1, and therefore, were not tabulated.

3. Runs 2 and 4 were compared to determine the percentage change in NET DEMAND that resulted from a 10% decrease in the adult incidence rates while the geriatric incidence rates were held constant. Table XXII summarizes this comparison and includes a listing of the sensitivity of NET DEMAND to a 1% decrease in the adult incidence rates.

4. Runs 2 and 7 were compared to determine the percentage change in NET DEMAND that resulted from a 10% increase in the adult incidence rates while the geriatric incidence rates were held constant. The calculated sensitivities were identical to those in the previous analysis, B-3, and therefore, were not tabulated.

5. Runs 2 and 5 were compared to determine the percentage change in NET DEMAND that resulted from a 10% decrease in both the geriatric and the adult incidence rates. Table XXIII summarizes this comparison and includes a listing of the sensitivity of NET DEMAND to a 1% decrease in both the geriatric and the adult incidence rates.

6. Runs 2 and 8 were compared to determine the change in NET DEMAND that resulted from a 10% increase in both the geriatric and the adult incidence rates. The calculated sensitivities were identical to those in the previous analysis, B-5, and therefore, were not tabulated.
TABLE XX

"SENSITIVITY" OF
TOTAL ADULT NET DEMAND
(IN PATIENT DAYS)

TO A 1% INCREASE IN THE PERCENTAGE
OF GERIATRIC POPULATION
TO THE TOTAL ADULT POPULATION

<table>
<thead>
<tr>
<th>District</th>
<th>Net Demand Total Adult (Standard)</th>
<th>Change In Net Demand</th>
<th>Geriatric Population Percent (Standard)</th>
<th>Geriatric Population Percent Increase</th>
<th>&quot;Sensitivity&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>128,364</td>
<td>21,792</td>
<td>7.99</td>
<td>5.12</td>
<td>3.32</td>
</tr>
<tr>
<td>Richmond</td>
<td>43,573</td>
<td>5,351</td>
<td>5.18</td>
<td>3.33</td>
<td>3.69</td>
</tr>
<tr>
<td>Vancouver</td>
<td>888,610</td>
<td>109,621</td>
<td>10.49</td>
<td>6.72</td>
<td>1.84</td>
</tr>
<tr>
<td>New West.</td>
<td>185,981</td>
<td>23,196</td>
<td>11.80</td>
<td>7.57</td>
<td>1.65</td>
</tr>
<tr>
<td>Burnaby</td>
<td>82,346</td>
<td>16,195</td>
<td>6.33</td>
<td>4.06</td>
<td>4.84</td>
</tr>
<tr>
<td>North Shore</td>
<td>134,302</td>
<td>17,790</td>
<td>6.10</td>
<td>3.92</td>
<td>3.38</td>
</tr>
</tbody>
</table>

TOTAL 1,463,176 193,945 13.26 7.90 5.07 2.62
# TABLE XXI

SENSITIVITY OF TOTAL ADULT NET DEMAND (IN PATIENT DAYS) TO A 1% DECREASE IN THE GERIATRIC INCIDENCE RATES

<table>
<thead>
<tr>
<th>District</th>
<th>Net Demand Total Adult (Run 2)</th>
<th>Change in Net Demand</th>
<th>% Change in Net Demand</th>
<th>Geriatric Incidence Rate % Change</th>
<th>Sensitivity (Col. 3 + Col.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>150,156</td>
<td>- 6,728</td>
<td>4.48</td>
<td>- 10.0</td>
<td>0.45</td>
</tr>
<tr>
<td>Richmond</td>
<td>49,924</td>
<td>- 1,652</td>
<td>3.38</td>
<td>- 10.0</td>
<td>0.34</td>
</tr>
<tr>
<td>Vancouver</td>
<td>998,231</td>
<td>-38,791</td>
<td>3.89</td>
<td>- 10.0</td>
<td>0.39</td>
</tr>
<tr>
<td>New West.</td>
<td>209,177</td>
<td>- 7,755</td>
<td>3.71</td>
<td>- 10.0</td>
<td>0.37</td>
</tr>
<tr>
<td>Burnaby</td>
<td>98,541</td>
<td>- 4,898</td>
<td>4.97</td>
<td>- 10.0</td>
<td>0.50</td>
</tr>
<tr>
<td>North Shore</td>
<td>151,092</td>
<td>- 5,702</td>
<td>3.75</td>
<td>- 10.0</td>
<td>0.37</td>
</tr>
</tbody>
</table>

**TOTAL** 1,657,121 -65,526 - 3.95 - 10.0 0.40
TABLE XXII

SENSITIVITY OF TOTAL ADULT NET DEMAND (IN PATIENT-DAYS) TO A 1% DECREASE IN THE ADULT INCIDENCE RATES

<table>
<thead>
<tr>
<th>District</th>
<th>Net Demand Total Adult (Run 2)</th>
<th>Change In Net Demand</th>
<th>% Change Net Demand</th>
<th>Adult Incidence Rate % Change</th>
<th>Sensitivity (Col. 3 + Col. 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>150,156</td>
<td>- 8,317</td>
<td>- 5.53</td>
<td>- 10.0</td>
<td>0.55</td>
</tr>
<tr>
<td>Richmond</td>
<td>49,924</td>
<td>- 3,257</td>
<td>- 6.65</td>
<td>- 10.0</td>
<td>0.67</td>
</tr>
<tr>
<td>Vancouver</td>
<td>998,231</td>
<td>-61,022</td>
<td>- 6.11</td>
<td>- 10.0</td>
<td>0.61</td>
</tr>
<tr>
<td>New West.</td>
<td>209,177</td>
<td>-13,170</td>
<td>- 6.30</td>
<td>- 10.0</td>
<td>0.63</td>
</tr>
<tr>
<td>Burnaby</td>
<td>98,541</td>
<td>- 4,956</td>
<td>- 5.03</td>
<td>- 10.0</td>
<td>0.50</td>
</tr>
<tr>
<td>North Shore</td>
<td>151,092</td>
<td>- 9,383</td>
<td>- 6.17</td>
<td>- 10.0</td>
<td>0.62</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1,657,121</strong></td>
<td><strong>- 100,105</strong></td>
<td><strong>- 6.04</strong></td>
<td><strong>- 10.0</strong></td>
<td><strong>0.60</strong></td>
</tr>
</tbody>
</table>
74.

**TABLE XXIII**

SENSITIVITY OF
TOTAL ADULT NET DEMAND
(IN PATIENT-DAYS)
TO A 1% DECREASE IN
BOTH THE GERIATRIC AND
THE ADULT INCIDENCE RATES

<table>
<thead>
<tr>
<th>District</th>
<th>Net Demand (Run 2)</th>
<th>Change In Net Demand</th>
<th>% Change Net Demand</th>
<th>% Change Incidence Rates</th>
<th>Sensitivity (Col. 3 + Col. 4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>150,156</td>
<td>- 15,045</td>
<td>-10.02</td>
<td>-10.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Richmond</td>
<td>48,924</td>
<td>- 4,909</td>
<td>-10.03</td>
<td>-10.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Vancouver</td>
<td>998,231</td>
<td>- 99,813</td>
<td>-10.00</td>
<td>-10.0</td>
<td>1.00</td>
</tr>
<tr>
<td>New West.</td>
<td>209,177</td>
<td>- 20,925</td>
<td>-10.00</td>
<td>-10.0</td>
<td>1.00</td>
</tr>
<tr>
<td>Burnaby</td>
<td>98,541</td>
<td>- 9,854</td>
<td>-10.00</td>
<td>-10.0</td>
<td>1.00</td>
</tr>
<tr>
<td>North Shore</td>
<td>151,092</td>
<td>- 15,086</td>
<td>-9.92</td>
<td>-10.0</td>
<td>0.99</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>1,657,121</td>
<td>165,632</td>
<td>-10.00</td>
<td>-10.0</td>
<td>1.00</td>
</tr>
</tbody>
</table>
THE POLICY ANALYSIS

A. POPULATION

The population of the G.V.R.H.D's age-sex groups by district were increased by 10%, as explained in Chapter VI, and the results were compared to the Standard Forecast. Table XXIV shows this comparison with the Standard Forecast as the base.

B. INCIDENCE RATES

The incidence rates of the G.V.R.H.D's. age-sex groups by district were increased by 10%, as explained in Chapter VI and the results were compared to the Standard Forecast. The calculated results were identical to the previous policy analysis, Population, and therefore, were not tabulated.

C. INFLOW

The inflow of patient-days to the G.V.R.H.D. was reduced by 10% as explained in Chapter VI and the results were compared to the Standard Forecast. Table XXV shows this comparison with the Standard Forecast as the base.

D. TRANSFER MATRIX

The Transfer Matrix, designed to reflect the ultimate patient-transfer policy described in Chapter VI, was used in the computer forecasting program to produce Policy Forecast D. Table XXVI compares this forecast to the Standard Forecast, which is used as the base.
E. OCCUPANCY PERCENTAGE

The Poisson method of estimating the forecast Requirement for Hospital Beds above the forecast Average Daily Census to accommodate fluctuations in the demand for hospital admissions, described in Chapter VI, was applied to the forecast Average Daily Census of individual hospitals. The hospitals' forecast bed-compliments were summed by district to form Policy Forecast E. Table XXVII compares Policy Forecast E to the Standard Forecast, which is used as the base.
## TABLE XXIV

**COMPARISON BETWEEN**

**THE STANDARD FORECAST**

**AND POLICY FORECAST A**

**(POPULATION)**

<table>
<thead>
<tr>
<th>Districts</th>
<th>Forecast Hospital Bed Requirements (Standard)</th>
<th>Forecast Hospital Bed Requirements (Policy A)</th>
<th>Increase</th>
<th>% Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>475</td>
<td>522</td>
<td>47</td>
<td>10.0</td>
</tr>
<tr>
<td>Ladner</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Richmond</td>
<td>172</td>
<td>188</td>
<td>16</td>
<td>9.3</td>
</tr>
<tr>
<td>Vancouver</td>
<td>3,099</td>
<td>3,407</td>
<td>308</td>
<td>9.9</td>
</tr>
<tr>
<td>New West.</td>
<td>663</td>
<td>729</td>
<td>66</td>
<td>10.0</td>
</tr>
<tr>
<td>Burnaby</td>
<td>306</td>
<td>336</td>
<td>30</td>
<td>9.8</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>North Shore</td>
<td>468</td>
<td>516</td>
<td>48</td>
<td>10.3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,183</strong></td>
<td><strong>5,698</strong></td>
<td><strong>515</strong></td>
<td><strong>9.9</strong></td>
</tr>
</tbody>
</table>
### TABLE XXV

**COMPARISON BETWEEN**

**THE STANDARD FORECAST**

**AND POLICY FORECAST C**

(INFLOW)

<table>
<thead>
<tr>
<th>Districts</th>
<th>Forecast Hospital Bed Requirements (Standard)</th>
<th>Forecast Hospital Bed Requirements (Policy C)</th>
<th>Decrease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>475</td>
<td>471</td>
<td>5</td>
</tr>
<tr>
<td>Ladner</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Richmond</td>
<td>172</td>
<td>172</td>
<td>0</td>
</tr>
<tr>
<td>Vancouver</td>
<td>3,099</td>
<td>3,043</td>
<td>56</td>
</tr>
<tr>
<td>New Westminster</td>
<td>663</td>
<td>656</td>
<td>7</td>
</tr>
<tr>
<td>Burnaby</td>
<td>306</td>
<td>306</td>
<td>0</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>North Shore</td>
<td>468</td>
<td>461</td>
<td>7</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,183</strong></td>
<td><strong>5,109</strong></td>
<td><strong>74</strong></td>
</tr>
</tbody>
</table>
### TABLE XXVI

**COMPARISON BETWEEN THE STANDARD FORECAST AND POLICY FORECAST D (TRANSFER MATRIX)**

<table>
<thead>
<tr>
<th>Districts</th>
<th>Forecast Hospital Bed Requirements (Standard)</th>
<th>Forecast Hospital Bed Requirements (Policy D)</th>
<th>Difference</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>475</td>
<td>571</td>
<td>+ 96</td>
<td>+ 20.2</td>
</tr>
<tr>
<td>Ladner</td>
<td>0</td>
<td>80</td>
<td>+ 80</td>
<td>∞</td>
</tr>
<tr>
<td>Richmond</td>
<td>172</td>
<td>217</td>
<td>+ 45</td>
<td>+ 26.2</td>
</tr>
<tr>
<td>Vancouver</td>
<td>3,099</td>
<td>2,798</td>
<td>- 301</td>
<td>- 9.7</td>
</tr>
<tr>
<td>New West.</td>
<td>663</td>
<td>400</td>
<td>- 263</td>
<td>- 40.0</td>
</tr>
<tr>
<td>Burnaby</td>
<td>306</td>
<td>435</td>
<td>+ 129</td>
<td>+ 42.2</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>0</td>
<td>230</td>
<td>+ 230</td>
<td>∞</td>
</tr>
<tr>
<td>North Shore</td>
<td>468</td>
<td>458</td>
<td>- 10</td>
<td>- 2.1</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>5,183</td>
<td>5,189</td>
<td>+ 6 *</td>
<td>+ 0.6</td>
</tr>
</tbody>
</table>

*This slight difference from Standard results from the exclusion of OUTFLOW from the Policy Forecast for convenience in programming the Transfer Matrix.*
TABLE XXVII

COMPARISON BETWEEN

THE STANDARD FORECAST

AND POLICY FORECAST E

(OCUPANCY PERCENTAGE)

<table>
<thead>
<tr>
<th>Districts</th>
<th>Forecast Hospital Bed Requirements (Standard)</th>
<th>Forecast Hospital Bed Requirements (Policy E)</th>
<th>Difference</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>475</td>
<td>504</td>
<td>+ 29</td>
<td>+ 6.1</td>
</tr>
<tr>
<td>Ladner</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Richmond</td>
<td>172</td>
<td>188</td>
<td>+ 16</td>
<td>+ 9.3</td>
</tr>
<tr>
<td>Vancouver</td>
<td>3,099</td>
<td>3,203</td>
<td>+ 104</td>
<td>+ 3.4</td>
</tr>
<tr>
<td>New West.</td>
<td>663</td>
<td>689</td>
<td>+ 26</td>
<td>+ 3.9</td>
</tr>
<tr>
<td>Burnaby</td>
<td>306</td>
<td>320</td>
<td>+ 14</td>
<td>+ 4.6</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>North Shore</td>
<td>468</td>
<td>479</td>
<td>+ 11</td>
<td>+ 2.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5,183</strong></td>
<td><strong>5,383</strong></td>
<td><strong>+ 200</strong></td>
<td><strong>+ 3.9</strong></td>
</tr>
</tbody>
</table>
CHAPTER VIII

DISCUSSION

THE STANDARD FORECAST

The B.C.H.P. planning proposal was based on their forecast of the Gross Demand (in patient days) expected by the G.V.R.H.D.'s districts. The connection between that forecast and the B.C.H.P. hospital-bed proposal was never established. However, I suspect that arbitrary decisions were made when the forecast Gross Demands of an individual district were compared to the number of hospital beds currently in operation in that district. The B.C.H.P. proposal, then, is not strictly a forecast, whereas the computer forecasting program's rebuttal to it is a forecast, based on specified assumptions. Nevertheless, the two "forecasts" were compared here to reveal the differences created by the use of different approaches to translate Gross to Net Demand for hospital services in each district. Table XXVIII transforms the balance (difference) data in Tables XVI to XIX into percentages of the computer program's Standard Forecast of Hospital-Bed Requirements.

Before analysing this data, a complicating factor must be explained. Since patients can only transfer to districts that have hospitals, the districts of Coquitlam, Ladner and North Delta, with no hospitals of their own, export 100% of their patients and are shown on the G.V.R.H.D. forecast with no forecast Net Demand, and thus, no requirement for hospital beds. Obviously, this is not strictly true.

There was considerable debate in 1976 as to whether Coquitlam and Ladner had sufficient Gross Demand and access to inflow patient-days from
## TABLE XXVIII

VARIATION BETWEEN

B.C.H.P. AND G.V.R.H.D. HOSPITAL

BED FORECASTS EXPRESSED

AS % G.V.R.H.D. FORECAST

<table>
<thead>
<tr>
<th>AREA</th>
<th>PAEDIATRIC</th>
<th>MATERNITY</th>
<th>ADULT</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>2.3</td>
<td>22.0</td>
<td>17.6</td>
<td>12.4</td>
</tr>
<tr>
<td>LADNER</td>
<td>-</td>
<td>-</td>
<td>∞</td>
<td>∞</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>85.7</td>
<td>20.0</td>
<td>30.1</td>
<td>33.1</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>21.3</td>
<td>14.3</td>
<td>3.4</td>
<td>5.3</td>
</tr>
<tr>
<td>NEW WEST.</td>
<td>7.8</td>
<td>13.0</td>
<td>1.2</td>
<td>0.8</td>
</tr>
<tr>
<td>BURNABY</td>
<td>27.6</td>
<td>3.8</td>
<td>43.4</td>
<td>38.0</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>-</td>
<td>-</td>
<td>∞</td>
<td>∞</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>7.7</td>
<td>5.9</td>
<td>0.2</td>
<td>2.6</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7.4</td>
<td>4.8</td>
<td>3.1</td>
<td>1.8</td>
</tr>
</tbody>
</table>
neighbouring districts, to justify the establishment of their own hospitals. B.C.H.P. said "yes" and proposed a new hospital in each of the two districts; the G.V.R.H.D. said "no" and did not so propose. For this reason, an infinite percentage difference exists between the B.C.H.P. and the Standard forecasts of the Hospital-Bed Requirements of Coquitlam and Ladner.

Table XXVIII shows that there is considerable variation between the two forecasts. Although the overall B.C.H.P. total differs by only 1.8% from the G.V.R.H.D. forecast, individual age-sex group forecasts for individual districts have some substantial variations. For example, the 85.7% variation in Richmond's paediatric forecast reflects an absolute variation of 12 beds. While this is not a large variation, it could considerably affect the planning of a paediatric unit within an individual hospital. The 43.4% variation in Burnaby's adult bed forecast is a lower percent than that of the previous example, but the absolute variation is 109 beds - a large and critical variation.

In summary, this analysis reveals that, although the B.C.H.P. and G.V.R.H.D. forecasting policies and methods are not strictly comparable, the two forecasts do not vary significantly overall, as is to be expected considering their common data. However, the allocations of the overall Net Demand to age-sex groups by district do vary significantly. This is also expected considering the two different allocation methods: B.C.H.P.'s intuition and the computer forecasting program's 1975 Transfer Matrix.

THE SENSITIVITY ANALYSIS

A. SENSITIVITY TO POPULATION CHANGES

Without an opportunity to study the data, an outside observer might propose that for the districts with high proportions of elderly people in
their total adult populations, the sensitivities of their Net Demands for hospital services to changes in the geriatric population would be high. Since the geriatric incidence rate is approximately four times that of other adults, this proposal is reasonable.

Table XX in Chapter VII shows that this is not necessarily the case. As described in Chapter VI, the geriatric populations of the G.V.R.H.D. districts were increased by approximately 64% above the standard geriatric / total adult ratios. The resulting percentages of geriatric population in 1981 vary from 5.18% in Richmond to 11.80% in New Westminster. The intra-Regional patient transfer redistributed the increase in patient days with the result that some areas, notably Burnaby, received "more than their share" when their percent increase in net demand is compared with their percent increase in geriatric population.

For example, the general 64% increase in absolute numbers of elderly people raised Burnaby's percentage of geriatric population to total adult population from 6.33% to 10.40% - an increase of 4.07%. However, Table XX shows that the same general increase raised the forecast of the total-adult-Net Demand for hospital services by 19.67%. Thus, for every 1% increase in the geriatric population, the net demand was increased by 4.84%; a sensitivity of 4.84. By comparison, New Westminster's sensitivity to a 1% increase in the geriatric population was 1.65 even though their geriatric population is 11.80% of their total adult population while that of Burnaby is only 6.33%. This can be explained by the fact that Burnaby has the highest geriatric inflow proportion of total adult Inflow of the G.V.R.H.D.'s districts as shown in Table XXIX.

This table shows that Burnaby is forecast to import 36,787 adult patient-days or 45% of the 82,346 adult patient-days that it is forecast to accommodate, and of those imported patient-days, 33% are geriatric.
# TABLE XXIX

PROPORTION OF GERIATRIC INFLOW TRANSFERS TO TOTAL ADULT INFLOW TRANSFERS*

<table>
<thead>
<tr>
<th>AREA</th>
<th>ADULT NET DEMAND</th>
<th>ADULT INFLOW</th>
<th>GERIATRIC INFLOW</th>
<th>GERIATRIC PROPORTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>128,364</td>
<td>26,612</td>
<td>3,406</td>
<td>.138</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>43,573</td>
<td>9,062</td>
<td>2,109</td>
<td>.233</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>888,610</td>
<td>322,524</td>
<td>46,768</td>
<td>.145</td>
</tr>
<tr>
<td>NEW WEST.</td>
<td>185,981</td>
<td>143,457</td>
<td>31,641</td>
<td>.221</td>
</tr>
<tr>
<td>BURNABY</td>
<td>82,346</td>
<td>36,787</td>
<td>12,199</td>
<td>.332</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>134,302</td>
<td>19,581</td>
<td>2,611</td>
<td>.133</td>
</tr>
</tbody>
</table>

*Calculated from the Standard Forecast using the Transfer Matrix.
Thus, Burnaby's adult Net Demand is highly susceptible to changes in the geriatric population of the G.V.R.H.D. Without the patient transfers among the districts, the calculation of the Net Demand would be a linear process and thus, the sensitivity of the output to changes in the input would be equal for all districts.

B. SENSITIVITY TO INCIDENCE RATE CHANGES

1. § 2. In this analysis of sensitivity, the geriatric Incidence Rates were lowered by 10% and then were raised by 10% while the adult Rates were held constant at standard values. The summary of the sensitivity by district to the 10% decrease in the geriatric Incidence Rates, Table XXI in Chapter VII, again shows that the sensitivities of the districts' Net Demand vary among the districts. Somewhat as before, Burnaby's Net Demand decreased by 4.97% following the 10% drop in the geriatric Incidence Rates, a sensitivity of 0.50, while that of New Westminster, with a much higher percentage of elderly persons, decreased by only 3.71%, a sensitivity of 0.37. Burnaby's higher sensitivity can be explained by that district's high percentage of geriatric Inflow, as noted in the previous section.

Because the intra-Regional transfer patterns are constant for all the sensitivity analyses, the Net Demand of each district is equally sensitive to an identical increase or decrease in the standard Incidence Rates.

3. § 4. In this analysis of sensitivity, the adult Incidence Rates were lowered by 10% and then were raised by 10% while the geriatric Rates were held constant. The summary of the sensitivity by district to the 10% decrease in the adult Incidence Rates, Table XXII in Chapter VII, shows that, as expected, the sensitivities of the Net Demand by district vary
among the districts.

In addition, these sensitivities have a relationship to the sensitivities shown on Table XXI. Burnaby, for example, has the lowest sensitivity to a 10% decrease in the adult Incidence Rates, whereas it has the highest sensitivity to a 10% decrease in the geriatric Incidence Rates. This opposite order of district sensitivities was expected because a district with a high geriatric inflow proportion has a correspondingly low adult inflow proportion. Thus, this district's Net Demand is more sensitive to changes in the geriatric Incidence Rates than are the Net Demands of other districts, and correspondingly this district's Net Demand is less sensitive to changes in the adult Incidence Rates than are the Net Demands of other districts.

5. & 6. In this analysis of sensitivity, both the geriatric and the adult Incidence Rates were first decreased by 10% and then were increased by 10%. With the values of the other forecast variables held at Standard values, the Net Demand by district was expected to have a sensitivity of 1.0 to an equal percentage change in both the geriatric and the adult Incidence Rates. This is because the variation by district in the geriatric-adult inflow proportions will not affect the conversion of Gross to Net Demand. Table XXIII, Chapter VII, shows that the sensitivities are 1.0 which indicates that the computer forecasting program produces results consistent with those expected.

In summary, these examinations of the sensitivity of the computer forecasting program's output forecast to changes made to the values of the input variables have shown that the user of the program cannot assume a common output-response to changes in Populations and Incidence Rates.
An examination of the patient transfer patterns will reveal peculiarities of a particular district's hospital service patterns. If the combined pattern of all the districts is judged to be undesirable by the policy-makers, then the effects of revised patterns (TRANSFER MATRICES) can be analysed through the use of the computer forecasting program.

THE POLICY ANALYSIS

A. POPULATION

If an equal percentage increase is applied to all the population groups of the districts, the computer forecasting program should produce a forecast of Hospital-Bed Requirements that will be increased by the same percentage. This should occur because the equal percentage change in all the values of the population variable will be transmitted through the forecast process to the forecast of Hospital-Bed Requirements.

Table XXIV in Chapter VII shows that a 10.0% increase in all population groups of all districts produced an average increase of 9.9% in the Forecast Hospital-Bed Requirements. This slight difference is attributable to "rounding" in the conversion of Net Demand in patient-days to equivalent hospital-beds.

The computer forecasting program does not greatly assist in this analysis as the effects of a general population increase can be calculated manually with less complication.

B. INCIDENCE RATES

An equal percentage increase in all Incidence Rates of Hospitalization should produce an equivalent increase in the forecast of Hospital-Bed Requirements for the same reason stated in the previous section. The analysis, described in Chapter VII, of the effects of a 10% increase in
the Incidence Rates revealed that these effects were identical to the effects of the 10% population increase.

As in the population analysis, the computer forecasting program does not greatly assist in the analysis of the effects of general Incidence Rate changes. However, the program can assist in the analysis of differential changes in Population and Incidence Rates as discussed under the Sensitivity Analysis.

C. **INFLOW**

Table XXV in Chapter VII shows the effects of a 10% decrease in the Inflow patient-days to the G.V.R.H.D. Since the Inflow Transfer Vector (Standard) distributes 75% of the G.V.R.H.D.'s Inflow to Vancouver's specialized hospital services, it was expected that 75% of the reduction in Inflow would occur in Vancouver. In fact, Vancouver's Forecast Hospital-Bed Requirements were reduced by 56 beds or 75% of the total 74 bed reduction that resulted from the 10% decrease in Inflow.

Although the effects of changes in Inflow are completely predictable in this forecasting method, the computer forecasting program does produce an alternate forecast quickly and, thus, can assist the policy-analyst.

D. **TRANSFER MATRIX**

If the G.V.R.H.D. were to establish a policy that 80% of a district's Gross Demand should be serviced in local community hospitals (see Chapter III for Ontario's policy), then a theoretical Transfer Matrix could be used to forecast the effects of this policy. The Transfer Matrix described in Chapter VII was developed to reflect such a policy and was used to produce the policy forecast listed in Table XXVI in Chapter VII.
This policy would dramatically shift the distribution of hospital facilities from Vancouver and New Westminster to the surrounding districts. Once provided with this information, the policy maker must then weigh the social benefits of the policy against the costs. For example, New Westminster's revised Forecast Hospital-Bed Requirement is 40% below the Standard Forecast and also 40% below B.C.H.P.'s proposal for this district. The social benefits would have to be high to balance the high cost of the abandoned or underutilized capital facilities that would follow the implementation of this policy.

The computer forecasting program could be a valuable tool in this type of analysis because it quickly completes the necessary calculations to produce forecasts that can be used to analyse the effects of alternate patient distributions.

**E. OCCUPANCY PERCENTAGE**

As an alternative to the B.C.H.P. "desired" occupancy percentages, the Poisson method of accommodating demand fluctuations was applied to the Forecast Average Daily Census of each G.V.R.H.D. hospital. The results, shown in Table XXVII in Chapter VII, indicate that such a policy would increase the Forecast Hospital-Bed Requirements by an average of 3.9%, or 200 hospital beds.

The Poisson method, described in Chapter VI, accounts for 99.7% of the demand fluctuation. The cost of providing such a high level of service availability must be weighed against the health costs to the patient of not having sufficient bed-capacity available at some peak demand occasions. Also, such an analysis could initiate the investigation of alternate services to accommodate peak demand.
In summary, Table XXX displays the forecasts of Hospital Bed Requirements that resulted from the alternate policies discussed in Chapter VI. These policies were selected as examples of possible applications of the computer forecasting program. The program is best suited to the analysis of policies which incorporate differential changes in the values of input variables by age-sex group and by district. The program can quickly provide the policy analyst with a forecast of the net effect of these policies.
### TABLE XXX

**COMPARISON AMONG**

**THE B.C.H.P. PROPOSAL,**

**THE STANDARD FORECAST,**

**AND THE POLICY FORECASTS**

**OF HOSPITAL-BED REQUIREMENTS**

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>B.C.H.P. PROPOSAL</th>
<th>STANDARD FORECAST</th>
<th>POLICY A POPULATION</th>
<th>POLICY B INCIDENCE RATES</th>
<th>POLICY C INFLOW</th>
<th>POLICY D TRANSFER MATRIX</th>
<th>POLICY E OCCUPANCY PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
<td>416</td>
<td>475</td>
<td>522</td>
<td>522</td>
<td>471</td>
<td>571</td>
<td>504</td>
</tr>
<tr>
<td>LADNER</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>RICHMOND</td>
<td>229</td>
<td>172</td>
<td>188</td>
<td>188</td>
<td>172</td>
<td>217</td>
<td>188</td>
</tr>
<tr>
<td>VANCOUVER</td>
<td>2,936</td>
<td>3,099</td>
<td>3,407</td>
<td>3,407</td>
<td>3,043</td>
<td>2,798</td>
<td>3,203</td>
</tr>
<tr>
<td>NEW WEST.</td>
<td>668</td>
<td>663</td>
<td>729</td>
<td>729</td>
<td>656</td>
<td>400</td>
<td>689</td>
</tr>
<tr>
<td>BURNABY</td>
<td>422</td>
<td>306</td>
<td>336</td>
<td>336</td>
<td>306</td>
<td>435</td>
<td>320</td>
</tr>
<tr>
<td>COQUITLAM</td>
<td>75</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>230</td>
<td>0</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>456</td>
<td>468</td>
<td>516</td>
<td>516</td>
<td>461</td>
<td>458</td>
<td>479</td>
</tr>
</tbody>
</table>

**TOTAL**     | 5,277             | 5,183             | 5,698               | 5,698                    | 5,109         | 5,189                    | 5,383                         |
This thesis has studied the history and present availability of techniques for forecasting the demand for acute-care-hospital beds. A computerized forecasting program was developed, based on the current hospital planning method used in British Columbia, but with some improvements.

1. The current method of forecasting acute-care-bed demand in British Columbia does not use many of the refinements that have been developed and published. These refinements include the following:

   a) The separation of incidence rate into both the admission rate per 1,000 persons and the length of hospital stay, for different diagnostic categories.

   b) The division of districts into homogeneous population groups where possible.

   c) The recognition of intra-Regional patient transfers.

   d) The recognition of the distribution of inflow among district hospitals within the region.

   e) The use of occupancy criteria that take account of the size of the individual hospital rather than applying a set occupancy rate to all hospitals.

   f) The use of alternate forecasts to reflect most likely and least likely estimates of the principal variables.

2. The current British Columbia technique has been refined by including three of the above aspects: (b), (c), and (d).

The other improvements noted in #1 were not incorporated into the forecasting program, in order to conform with my explicit decision
to match the B.C.H.P. method as much as possible to focus discussion on the more important issue of a Transfer Matrix to accommodate intra-Regional patient transfers.

3. The computerization of the forecasting process was effective in that the B.C.H.P. results were reproduced when a neutral Transfer Matrix was used. This validation confirmed that the Transfer Matrix component was successfully integrated into the calculation sequence without distorting the forecast total Net Demand for hospital services.

4. The standard forecast produced by the computer program was compared with the B.C.H.P. forecast revealing that B.C.H.P.'s best estimated hospital bed allocation varied considerably from forecast requirements based on current patient flow patterns. My use of 1975 patient transfer data is subject to the criticism that it provides an entrenchment of the status quo, but, since the Standard Forecast was produced to show what might happen if present trends continue, and since the computer program was specifically designed to use alternate data, I do not believe that such criticism is valid.

5. The sensitivity of the technique to changes in the values of input variables was analysed by comparing the changes in output (Net Demand for hospital services) to the changes made to Population and Incidence Rates. This analysis revealed that the individual districts have different sensitivities to input data changes and that the output of each district does not vary in proportion to the variation made to the input data. This fact makes the computer forecasting program a valuable tool for the analysis of the possible effects caused by inaccurate population or incidence rate forecasts.

6. Once the computer forecasting program was tested and validated,
it was available to serve in the role for which it was designed: as a policy-analysis tool. Since hospital planning has been plagued by the questionable usefulness of input data, the process of forecasting the future demand for facilities has been frustrating for both researchers and policy analysts. The computer forecasting program cannot be used to improve the data fed into it, but it can be used to explore the range of data options, from most likely to least likely, to give the policy analyst a range of the possible results to be expected if an estimate, or policy decision, proves to be incorrect. Several alternate policy positions regarding the values of the program's variables were analysed, with the conclusion that the program is well suited for the analysis of differential changes made to the values of input variables by age-sex group and by district.

7. In conclusion, the computer forecasting program should now be improved by incorporating the remainder of the items previously noted under #1.
FIGURE 1.
FLOW DIAGRAM OF
THE COMPUTER FORECASTING PROGRAM

1. Multiply
POPULATION
By Age-Sex & District

2. Multiply
INCIDENCE RATE OF
HOSPITALIZATION
Annual by Age-Sex & District

3. Multiply
INCIDENCE RATES OF
HOSPITALIZATION
Annual by Age-Sex & District

4. Multiply
AVERAGE LENGTH OF STAY
In Days per Admission

5. Multiply
AVERAGE DAILY CENSUS
In Patient-Days by Age-Sex & District

6. Multiply
NET DEMAND
In Patient-Days by Age-Sex & District

7. Multiply
DISTRIBUTED INFLOW
By Age-Sex & Year

8. Multiply
DISTRIBUTED INFLOW
By Age-Sex & District

9. Divide
AVERAGE DAILY CENSUS
In Patient-Days by Age-Sex & District

10. Divide
INFLOW
In Patient-Days by Age-Sex & Year

11. Divide
FORECAST HOSPITAL BED
REQUIREMENTS
By Age-Sex & District

12. Divide
TRANSFER VECTOR

13. Divide
165 Days

14. Divide
R.C.H.P. Proposal

15. Compare
BALANCE OF BEDS REQUIRED

16. Compare
OCUPANCY PERCENTAGE
By Age-Sex
<table>
<thead>
<tr>
<th>Glossary Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily Census</td>
<td>The average daily number of beds that are expected to be used in a hospital or group of hospitals.</td>
</tr>
<tr>
<td>Average Length of Stay</td>
<td>The average length of time in days that patients reside in a hospital per admission.</td>
</tr>
<tr>
<td>Gross Total Demand for Hospitalization</td>
<td>The total number of patient days consumed by a population group or serviced by a geographical area excluding inflow and outflow.</td>
</tr>
<tr>
<td>Hospital Admissions Rate</td>
<td>The number of persons from a population group who are admitted to a hospital expressed as the number of admissions per 1000 persons per year.</td>
</tr>
<tr>
<td>Incidence Rate of Hospitalization</td>
<td>The number of patient-days consumed by a population group, usually 1000 persons, per year.</td>
</tr>
<tr>
<td>Inflow</td>
<td>The number of patient-days provided by hospitals in a district for patients whose residence is not in that district.</td>
</tr>
<tr>
<td>Net Total Demand for Hospitalization</td>
<td>The total number of patient days serviced by a geographic area including inflow and outflow.</td>
</tr>
<tr>
<td>Occupancy Percentage</td>
<td>The percentage of a hospital's total beds that are being used by patients at a point in time.</td>
</tr>
<tr>
<td>Outflow</td>
<td>The number of patient-days provided for the residents of a district by hospitals not in that district.</td>
</tr>
<tr>
<td>Patient Day</td>
<td>The use of one hospital bed by one patient for one day.</td>
</tr>
<tr>
<td>Relevance Index</td>
<td>The proportion of a population group's total number of patient days that are serviced at a specific hospital or in a specific geographic area.</td>
</tr>
</tbody>
</table>
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APPENDIX A

COMPUTER FORECASTING PROGRAM
*** A PROGRAM TO FORECAST ACUTE CARE HOSPITAL BEDS IN THE GVHRD ***

** CLEAR PREVIOUS RUN'S PRINT OUTPUT FILE

** CLEAR PREVIOUS RUN'S SUMMARY FILE.

** INITIALIZE THE RUN COUNTER.

** OPEN OUTPUT FILE (DISK) FOR PRINTING.

** SUM INDIVIDUAL RUNS ON DISK FILE.

** READ AREA TITLES.

** DIMENSION THE VIRTUAL ARRAYS ON DISK ***

** INITIALIZE THE VIRTUAL ARRAYS ***

** MESSAGE FOR USER ON TERMINAL.

** ANOTHER FORECAST SEQUENCE HAS STARTED.'

** : PRINT ''

** INSTRUCTIONS FROM TERMINAL ***

** IF THIS IS A MATERNITY FORECAST, TYPE IN THE WORD YES', M$

** IF M$='YES' GO TO 600 ; PRINT ' ' 1

** WHAT IS THE TITLE OF THIS FORECAST

** DATE PREPARED

** IF THIS IS AN ADULT FORECAST, TYPE IN THE WORD YES', A$

** PRINT ' ' 1

** WHAT IS THE TITLE OF THIS FORECAST

** DATE PREPARED

** IF K%=5 GO TO 600

** IF K%=5 GO TO 600

** IF K%=5 GO TO 600

** IF K%=5 GO TO 600

** IF K%=5 GO TO 600

** IF K%=5 GO TO 600

** IF K%=5 GO TO 600
INPUT 'WHICH POPULATION FORECAST USED', $PS
INPUT 'WHICH TRANSFER MATRIX USED', $FS
INPUT 'WHICH PLANNED BED TOTALS USED', $GS
INPUT 'ANY COMMENTS TO ADD', $RS
INPUT 'ANY MORE COMMENTS TO ADD', $OS
INPUT 'LAST CHANCE FOR COMMENTS', $JS

IF R%=5 GO TO 5360
PRINT ' ' 730!

INPUT 'NAME OF INCIDENCE RATE DATA FILE TO BE USED', $RS
INPUT 'NAME OF POPULATION DATA FILE TO BE USED', $PS
INPUT 'NAME OF PLANNED BEDS DATA FILE TO BE USED', $BS
INPUT 'NAME OF INFLOW RATE DATA FILE TO BE USED', $OS
INPUT 'NAME OF OUTFLOW RATE DATA FILE TO BE USED', $GS
INPUT 'NAME OF INFLOW DISTRIBUTION FILE TO BE USED', $JS
PRINT ' ' 780
PRINT 'STANDARD OCCUPANCY RATES: PAEDS = .85  MAT = .80  ADULT = .90'
PRINT ' ' 790
INPUT 'WHICH OCCUPANCY RATE TO BE USED', $01
PRINT ' ' 800

OPEN $RS FOR INPUT AS FILE 2%
OPEN $PS FOR INPUT AS FILE 3%
OPEN $BS FOR INPUT AS FILE 4%
OPEN $OS FOR INPUT AS FILE 5%
OPEN $JS FOR INPUT AS FILE 6%
OPEN $IS FOR INPUT AS FILE 8%

*** DIMENSION THE ARRAYS ***

DIM #2%, R(9) ! INCIDENCE RATES PER 1000 POPULATION.
DIM #3%, P(9) ! POPULATION IN THOUSANDS.
DIM #4%, B(9) ! PLANNED BEDS BY AREA.
DIM #5%, C(9) ! OUTFLOW BY AREA AS % AREA TOTAL VOLUME.
DIM #6%, T(9,9) ! INTERNAL GVRHD TRANSFERS AS % AREA VOLUME.
DIM #8%, F(9) ! INFLOW DISTRIBUTION AS % TOTAL INFLOW.
DIM D(9) ! PATIENT DAYS.
DIM D1(9) ! NET PATIENT DAYS.
DIM G1%(4) ! REGROUPING OF PLANNED BEDS.
DIM G2%(4) ! REGROUPING OF NEEDED BEDS.
DIM B%(9) ! NET BED REQUIREMENT.
DIM X%(9) ! NEEDED BEDS BY AREA.
DIM BS$(4) ! NAMES OF AREA GROUPS.
DIM AS$(9) ! NAMES OF AREAS.
DIM P9(9) ! CORRECTION FOR MATERNITY POPULATION COUNT.
DIM X9(9) ! SUM OF MATRIX PERCENTAGES BY AREA.
DIM X8(9) ! SUM OF ACCUMULATED MATRIX PERCENTAGES BY AREA.

*** CALCULATION OF PATIENT DAYS ***

RESTORE ! RECYCLE DATA FOR THE NEXT READ STATEMENT.

FOR I=1 TO 9
D(I)=R(I)*P(I) ! PATIENT DAYS=INCIDENCE RATE X POPULATION.
31=S1+D(I) ! TOTAL OF PATIENT DAYS.
NEXT I
$T(I) = T(I) + P(I)$

$T2(I) = T2(I) + D(I)$

$T3 = T3 + D(I)$

$T4 = T4 + P(I)$

$T5(I) = T2(I) / T1(I)$

$R% = R% + S1 / P2$

IF $M$ <> 'YES' GO TO 1480

FOR $J = 1$ TO 9
  $P9(J) = P(J)$
  $P9 = P9 + P(J)$
NEXT $J$

IF $P9 <> 0$ AND $A$ = 'YES' GO TO 1510

GO TO 1560

FOR $I = 1$ TO 9
  $T1(I) = T1(I) - P9(I)$
  $T4 = T4 - P9$
  $T6% = T3 / T4$

* * *

**INTERNAL GVRHD TRANSFERS**

** * * *

FOR $I = 1$ TO 9
  FOR $J = 1$ TO 9
    $D1(J) = D1(J) + T(I,J) * D(I)$
    $X(I,J) = X(I,J) + (T(I,J) * D(I))$
    $Y(I,J) = X(I,J) / T2(I)$
    $X9(I) = X9(I) + T(I,J)$
    $X8(I) = X8(I) + Y(I,J)$
  NEXT $J$

$V0(I) = V0(I) + (C(I) * D(I))$
$V1(I) = V0(I) / T2(I)$
$X7 = X7 + (C(I) * D(I))$
$X9(I) = X9(I) + C(I)$
$X8(I) = X8(I) + V1(I)$

$X6 = X6 + X7$

$T2 = S1 * L$

$T = T + T2$

FOR $I = 1$ TO 9
  $D1(I) = D1(I) + T2*F(I)$
  $D2 = D2 + D1(I)$
**BED NEED CALCULATIONS**

```
1760 10=I0 (I)
1980 T9 (I)=T9 (I)+(T2*F(I))
1990 U0 (I)=T9 (I)/T

2010 NEXT I
2020
2030 B%=T2/(365*O1)
2040 U1=U1+B%
2050 U2=T/T3
2060!
2070!
2080! *** BED NEED CALCULATIONS ***
2090!
3000!
3020!
3030 FOR J=1 TO 9
3040 X%(J)=D1(J)/(365*O1)+0.5
3050 B%(J)=B(J)-X%(J)
3060 A%=A%+B(J)
3070 C%=C%+X%(J)
3080 D%=D%+B%(J)
3090!
3450!
3000 U3%(J)=U3%(J)+X%(J)
3010 U4%(J)=U4%(J)+B(J)
3020 U5%(J)=U5%(J)+B%(J)
3030 U6%=U6%A%(J)
3040 U7%=U7%A%(J)
3050 U8%=U8%A%(J)
3060!
3070 NEXT J
3075!
3080 GO TO 5360
3090!
5000! *** REGROUP THE GEOGRAPHIC AREAS ***

5010!
5020!
5030 G1%(1)=B(9)
5040 G1%(2)=B(5)+B(7)
5050 G1%(3)=B(3)+B(4)
5060 G1%(4)=B(1)+B(2)+B(6)+B(8)
5070!
5080 G2%(1)=X%(9)
5090 G2%(2)=X%(5)+X%(7)
5100 G2%(3)=X%(3)+X%(4)
5110 G2%(4)=X%(1)+X%(2)+X%(6)+X%(8)
5120!
5130 A%=0.
5140 C%=0.
5150 D%=0.
5160!
5170 FOR J=1 TO 4
5180 B%(J)=G1%(J)-G2%(J)
5190 A%=A%+G1%(J)
5200 C%=C%+G2%(J)
5210 D%=D%+B%(J)
5220 V1%(J)=V1%(J)+G1%(J)
5230 V2%(J)=V2%(J)+G2%(J)
5240 V3%(J)=V3%(J)+B%(J)
5250!
5260 NEXT J
5270!
5280 V4%=V4%A%
5290 V5%=V5%A%+C%
5300 V6%=V6%A%+D%
```

---

**INFLOW AS BEDS.**

**TOTAL INFLOW AS BEDS.**

**OVERALL INFLOW RATE AS % GVRHD DAYS.**

**BED NEED = DAYS/OCCUPANCY RATE.**

**SUM OF PLANNED BEDS.**

**SUM OF NEEDED BEDS.**

**NET BED BALANCE.**

**ACUMULATION OF BED NEED BY AREA.**

**ACUMULATION OF PLANNED BEDS BY AREA.**

**ACUMULATION OF BED BALANCES BY AREA.**

**ACUMULATION OF TOTAL BEDS.**

**ACUMULATION OF NEEDED BEDS.**

**ACUMULATION OF BED BALANCE.**

**NORTH = NORTH SHORE.**

**CENTRAL = VANCOUVER + BURNABY.**

**SOUTH = LADNER + RICHMOND.**

**EAST = SURREY + WHITE ROCK + N DELTA + NEW WEST + COQUITLAM.**

**REGROUP NEEDED BEDS.**

**RESET TOTALS TO ZERO.**

**BED BALANCE.**

**TOTAL PLANNED BEDS.**

**TOTAL NEEDED BEDS.**

**NET BED BALANCE.**

**ACUMULATE PLANNED BEDS.**

**ACUMULATE NEEDED BEDS.**

**ACUMULATE BED BALANCE.**

**ACUMULATE TOTAL PLANNED BEDS.**

**ACUMULATE TOTAL NEEDED BEDS.**

**ACUMULATE TOTAL BED BALANCE.**
**FOR 1 = 1 TO 14**

**PRINT #1,**

**FORECAST OF GVHHD**

**ACUTE CARE HOSPITAL BEDS**

**DATA USED:**

- INCIDENCE RATE :
- POPULATION :
- TRANSFER MATRIX :
- PLANNED BEDS :

**REMARKS:**

**DATE PREPARED:**

**AREA**, **INCIDENCE**, **POPULATION**, **OWN DAYS**, **TOTAL DAYS**

**IF K%=5 GO TO 7960**
PRINT #1,: PRINT #1,
PRINT #1,'TOTALS';
PRINT #1, USING '###',R8;
PRINT #1, USING '###',P2*1000.;
PRINT #1, USING '###',S1;
PRINT #1, USING '###',D2
PRINT #1,: PRINT #1.: PRINT #1,
PRINT #1,'TRANSFER MATRIX ASSUMED'
PRINT #1, '**********************************************************'
PRINT #1,'PATIENT AREA OF HOSPITAL TREATMENT ORIGIN'
PRINT #1,**
PRINT #1,'OUT TOTAL'
FOR K=1 TO 9
PRINT #1, USING ' ',A$(K);
NEXT K
PRINT #1,'OUT TOTAL'
FOR I=1 TO 9
PRINT #1, USING '\ ',A$(I);
FOR J=1 TO 9
PRINT #1, USING '.### ',T(I,J);
NEXT J
PRINT #1, USING '.###', C(I);
PRINT #1, USING '#.###',X9(I)
PRINT #1,
NEXT I
FOR K=1 TO 8
NEXT K
PRINT #1,'INFLOW ASSUMED '; PRINT #1, USING ' ##.#',L*100.;
PRINT #1,' % OR AS BEDS: '; B%
PRINT #1, '**********************************************************'
PRINT #1,'OUTFLOW ASSUMED ';
PRINT #1, USING ' ##.#',X7/S1*100.;
PRINT #1,' % OR AS BEDS: ';
PRINT #1, USING ' ### ',X7/(365.*01)
PRINT #1, '**********************************************************'
FOR K=1 TO 5
PRINT #1,
NEXT K
PRINT #1,'INFLOW ASSUMED '; PRINT #1, USING ' ##.#',L*100.;
PRINT #1,' % OR AS BEDS: ';
PRINT #1, '**********************************************************'
PRINT #1,'DISTRIBUTION OF INFLOW'
PRINT #1,'BY AREA (PERCENTAGE)'
PRINT #1,'**********************************************************'
PRINT #1,
IF K%=5 GO TO 8550
FOR I=1 TO 9
F1%=F1%+(F(I)*1000.);
PRINT #1, USING '\ ',A$(I);
PRINT #1, USING ' ##.#',F(I)*100
NEXT I
PRINT #1, 'TOTAL 
PRINT #1, USING '###.#',F1%/10
FOR J=1 TO 6 : PRINT #1, : NEXT J
PRINT #1,'OCCUPANCY RATE ASSUMED'
PRINT #1, '********************
PRINT #1, 'PAEDIATRICS - 85% : MATERNITY - 80% : ADULT - 90%
IF K%=5 GO TO 3660
PRINT #1, 'THE OCCUPANCY RATE FOR THIS FORECAST IS ';
PRINT #1,01*100;"%
PRINT #1, CHR$(12%)
PRINT #1, '***************************************** '
PRINT #1,'***** GVRHD BED NEED FORECAST BY AREA *****
PRINT #1, 'AREA','PLANNED BEDS','NEEDED BEDS','BALANCE
PRINT #1, '****', '*************', '***********', '************
IF K%=5 GO TO 8860
PRINT #1, A$(1),B(1),X%(1),B%(1)
PRINT #1, FOR I=3 TO 9
PRINT #1, A$(I),B(I),X%(I),B%(I)
NEXT I
PRINT SURREY'S NEEDS.
PRINT OTHER AREAS' NEEDS
PRINT 'TOTALS',A%,C%,D%
FOR J=1 TO 6 : PRINT #1, : NEXT J
PRINT #1, '************'*****','*******','************
PRINT #1, 'TOTALS',A8%,C8%,D8%
FOR J=1 TO 6 : PRINT #1, : NEXT J
PRINT #1, '************* GVRHD BED NEED FORECAST BY REGROUPED AREAS *****
PRINT #1, 'AREA','PLANNED BEDS','NEEDED BEDS','BALANCE'
PRINT #1, '****', '*************', '***********', '************
IF K%=5 GO TO 8990
GO TO 5030
FOR K=1 TO 4
PRINT #1, B$(K),G1%(K),G2%(K),B%(K)
PRINT #1, NEXT K
PRINT #1, 'EXPLANATION OF AREAS'
PRINT #1, '********************
PRINT #1, '************'*****','*******','************
PRINT #1, '2. CENTRAL = VANCOUVER AND BURNABY.'
PRINT #1, '3. SOUTH = RICHMOND AND LADNER.'
PRINT #1, '4. EAST = COQUITLAM, NEW WESTMINSTER, NORTH DELTA,'
PRINT #1, 'SURREY AND WHITE ROCK.'

IF K%=5 GO TO 9410

***** RESET TOTALS FOR ANOTHER FORECAST RUN *****
MAT D = ZER
MAT D1 = ZER
MAT G1% = ZER
MAT G2% = ZER
MAT B% = ZER
MAT X9 = ZER
MAT X% = ZER
MAT A% = 0
MAT C% = 0
MAT D% = 0
MAT R% = 0
MAT S = 0.
MAT S1 = 0.
MAT P1% = 0
MAT T2 = 0.
MAT P2 = 0.
MAT X7 = 0.
MAT X8 = ZER
MAT X% = ZER
MAT X1% = Cl%+1

***** INSTRUCTIONS TO THE USER *****
PRINT
PRINT 'RUN #';C1%;' IS COMPLETE.'
IF K%=6 GO TO 9410
PRINT
INPUT 'IF YOU WANT TO SUMMARIZE THESE FORECASTS, TYPE IN THE # 5 ',K%
PRINT
IF K%<>5 GO TO 7850
CLOSE 9%
OPEN 'SUM' FOR INPUT AS FILE 9%
PRINT 'GIVE THE FOLLOWING INFORMATION FOR THE SUMMARY RUN:'
PRINT
GO TO 200
INPUT 'IF YOU WANT TO STOP NOW, TYPE IN THE # 6 ',K%
MAT X8 = ZER
IF K%=6 GO TO 9410
GO TO 490

**************************************************
***** PRINT SEQUENCE FOR THE SUMMARY FORECAST *****
**************************************************
1000 PRINT #1, USING '#####', T1(K)*1000.;
1010 PRINT #1, USING '#####', T2(K);
1020 PRINT #1,
1030 NEXT K
1040
1050 PRINT #1, : PRINT #1, : PRINT #1,
1060 PRINT #1, 'TOTALS ';
1070 PRINT #1, USING '#####', T68;
1080 PRINT #1, USING '#####', T4*1000.;
1090 PRINT #1, USING '#####', T3;
1100 PRINT #1, USING '#####', T8
1110 FOR K=1 TO 3 : PRINT #1, : NEXT K
1120 PRINT #1, 'TRANSFER MATRIX ASSUMED'
1130 PRINT #1, '***********************'
1140 PRINT #1, 'PATIENT AREA OF HOSPITAL TREATMENT ORIGIN'
1150 PRINT #1, '**************************'
1160 PRINT #1, 'OUT TOTAL'
1170 PRINT #1,
1180 FOR I=1 TO 9
1190 PRINT #1, USING '###',A$(I);
1200 NEXT I
1210 FOR K=1 TO 8
1220 PRINT #1, USING '#.###',X8(I)
1230 NEXT K
1240 FOR K=1 TO 9
1250 F2%=F2%+(U0(K)*10000.+.5)
1260 PRINT #1, USING '###.#', F2%/100
1270 PRINT #1, 'INFLOW ASSUMED ';
1280 PRINT #1, USING '##.#', U2*100.;
1290 PRINT #1, '% OR AS BEDS: ';U1
1300 PRINT #1, '**************'
1310 PRINT #1, 'OUTFLOW ASSUMED ';
1320 PRINT #1, USING '##.#', X6/T3*100.;
1330 PRINT #1, '% OR AS BEDS: ';X6/(T3/U7%)
1340 PRINT #1, '**************'
1350 GO TO 6450
1360 FOR K=1 TO 9
1370 PRINT #1, USING '###.',U0(K)*10000.+5)
1380 PRINT #1, USING '###.#',U0(K)*100.+0005
1390 NEXT K
1400 FOR K=1 TO 9
1410 PRINT #1, USING '#####', A$(K);
1420 PRINT #1, USING '#####', D0(K)*100.+0005
1430 NEXT K
1440 FOR K=1 TO 9
1450 PRINT #1, USING '#####', F2%/100
THE AVERAGE OCCUPANCY RATE FOR THIS FORECAST IS:

PRINT USING "##.#", (T8/(U7%*365.))*100.;

FOR K=1 TO 8 : PRINT #1, : NEXT K

PATIENT DAY FLOW STATISTICS

RESIDENT ACUTE PATIENT DAYS:

LESS OUTFLOW:

PLUS INFLOW:

NET GVHD PATIENT DAYS:

ACUTE CARE BED REQUIREMENTS:

TOTALS

TOTALS

*** HEADINGS ***

DATA 'SURREY','NORTH DELTA','LADNER','RICHMOND','VANCOUVER',
 'NEW WEST','BURNABY','COQUITLAM','NORTH SHORE'

DATA 'NORTH','CENTRAL','SOUTH','EAST'

DATA 'S','ND','L','R','V','NW','B','C','NS'

PRINT 'THIS FORECAST IS COMPLETE.' : PRINT '

PRINT 'TO PRINT THE RESULTS, RUN $QUE , QLP0:=BEDS.'

PRINT #1, : PRINT #1,

CLOSE 1%
CLOSE 6%
CLOSE 5%
CLOSE 4%
CLOSE 3%
CLOSE 2%
CLOSE 8%
CLOSE 9%
APPENDIX B

STANDARD FORECAST

...
GVRHD FORECAST
ACUTE HOSPITAL BEDS

TITLE: PAEDIATRIC (0-14) 1981

*****************************************************

DATA USED:

INCIDENCE RATES: R001
POPULATION P001
TRANSFERS M021
PLANNED BEDS B001

*****************************************************

REMARKS:

THIS IS THE STANDARD FORECAST.

DATE PREPARED: 1 OCTOBER
### ASSUMPTIONS USED IN FORECAST OF 1981 HOSPITAL BEDS

<table>
<thead>
<tr>
<th>AREA</th>
<th>INCIDENCE</th>
<th>POPULATION</th>
<th>OWN DAYS</th>
<th>TOTAL DAYS</th>
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</table>

**Totals**: 361, 259900, 93986, 129016

### TRANSFER MATRIX ASSUMED

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<tr>
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<th>AREA OF HOSPITAL TREATMENT</th>
</tr>
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<tr>
<td>Coquitlam</td>
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<tr>
<td>North Shore</td>
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INFLOW ASSUMED 38.0 % OR AS BEDS: 115

OUTFLOW ASSUMED 0.7 % OR AS BEDS: 2

DISTRIBUTION OF INFLOW
BY AREA (PERCENTAGE)

SURREY 5.0
NORTH DELTA 0.0
LADNER 0.0
RICHMOND 0.0
VANCOUVER 85.0
NEW WEST 5.0
BURNABY 0.0
COQUITLAM 0.0
NORTH SHORE 5.0
TOTAL 100.0

OCCUPANCY RATE ASSUMED

PAEDIATRICS - 85% : MATERNITY - 80% : ADULT - 90%

THE OCCUPANCY RATE FOR THIS FORECAST IS 85 %
### GVRHD Bed Need Forecast for 1981

<table>
<thead>
<tr>
<th>AREA</th>
<th>Planned Beds</th>
<th>Needed Beds</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
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<td>43</td>
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</tr>
<tr>
<td>Ladner</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Richmond</td>
<td>26</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Vancouver</td>
<td>200</td>
<td>254</td>
<td>-54</td>
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<tr>
<td>New West</td>
<td>55</td>
<td>51</td>
<td>4</td>
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<td>Burnaby</td>
<td>37</td>
<td>29</td>
<td>8</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>North Shore</td>
<td>24</td>
<td>26</td>
<td>-2</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>386</strong></td>
<td><strong>417</strong></td>
<td><strong>-31</strong></td>
</tr>
</tbody>
</table>

### GVRHD Bed Need Forecast for 1981 by Area

<table>
<thead>
<tr>
<th>AREA</th>
<th>Planned Beds</th>
<th>Needed Beds</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
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<td>26</td>
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<tr>
<td>Central</td>
<td>237</td>
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<tr>
<td>South</td>
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<td>East</td>
<td>99</td>
<td>94</td>
<td>5</td>
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<tr>
<td><strong>Totals</strong></td>
<td><strong>386</strong></td>
<td><strong>417</strong></td>
<td><strong>-31</strong></td>
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</table>

**Explanation of Areas**

1. North includes the North Shore
2. Central includes Vancouver and Burnaby
3. South includes Richmond and South Delta
4. East includes Coquitlam, New Westminster, North Delta, Surrey, and White Rock
GVRHD FORECAST
ACUTE HOSPITAL BEDS

TITLE: MATERNITY (15-45 FEMALE) 1981

DATA USED:
INCIDENCE RATES: R002
POPULATION P002
TRANSFERS M022
PLANNED BEDS B002

REMARKS:

THIS IS THE STANDARD FORECAST.

DATE PREPARED: 1 OCTOBER
**ASSUMPTIONS USED IN FORECAST OF 1981 HOSPITAL BEDS**

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<th>AREA</th>
<th>INCIDENCE</th>
<th>POPULATION</th>
<th>OWN DAYS</th>
<th>TOTAL DAYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURREY</td>
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<td>LADNER</td>
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<td>9100</td>
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<td>RICHMOND</td>
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<td>21250</td>
<td>7438</td>
<td>7236</td>
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<td>VANCOUVER</td>
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<td>88800</td>
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<td>NEW WEST</td>
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<td>BURNABY</td>
<td>300</td>
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<td>9825</td>
<td>7651</td>
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<td>COQUITLAM</td>
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<td>7930</td>
<td>0</td>
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<tr>
<td>NORTH SHORE</td>
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<td>32500</td>
<td>9620</td>
<td>10039</td>
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**TOTALS** 325 | 258650 | 84228 | 90966

**TRANSFER MATRIX ASSUMED**

<table>
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<tr>
<th>PATIENT ORIGIN</th>
<th>AREA OF HOSPITAL TREATMENT</th>
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<tr>
<td></td>
<td>S</td>
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<tr>
<td>SURREY</td>
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<td>NORTH DELTA</td>
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<td>LADNER</td>
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<tr>
<td>RICHMOND</td>
<td>.000</td>
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<tr>
<td>VANCOUVER</td>
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<td>NEW WEST</td>
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<td>BURNABY</td>
<td>.000</td>
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<tr>
<td>COQUITLAM</td>
<td>.000</td>
</tr>
<tr>
<td>NORTH SHORE</td>
<td>.000</td>
</tr>
</tbody>
</table>
INFLOW ASSUMED  8.0 % OR AS BEDS: 23

OUTFLOW ASSUMED  0.0 % OR AS BEDS: 0

DISTRIBUTION OF INFLOW
BY AREA (PERCENTAGE)

SURREY  10.0
NORTH DELTA  0.0
LADNER  0.0
RICHMOND  0.0
VANCOUVER  50.0
NEW WEST  20.0
BURNABY  5.0
COQUITLAM  0.0
NORTH SHORE  15.0
TOTAL  100.0

OCCUPANCY RATE ASSUMED

PAEDIATRICS - 85% : MATERNITY - 80% : ADULT - 90%

THE OCCUPANCY RATE FOR THIS FORECAST IS 80 %
### GVRHD Bed Need Forecast for 1981

#### By Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Planned Beds</th>
<th>Needed Beds</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>50</td>
<td>41</td>
<td>9</td>
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<tr>
<td>Ladner</td>
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<td>Richmond</td>
<td>30</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Vancouver</td>
<td>120</td>
<td>140</td>
<td>-20</td>
</tr>
<tr>
<td>New West</td>
<td>40</td>
<td>46</td>
<td>-6</td>
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<tr>
<td>Burnaby</td>
<td>25</td>
<td>26</td>
<td>-1</td>
</tr>
<tr>
<td>Coquitlam</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>North Shore</td>
<td>32</td>
<td>34</td>
<td>-2</td>
</tr>
</tbody>
</table>

**Totals:**
- Planned Beds: 297
- Needed Beds: 312
- Balance: -15

---

#### North

1. North includes the North Shore
2. Central includes Vancouver and Burnaby
3. South includes Richmond and South Delta
4. East includes Coquitlam, New Westminster, North Delta, Surrey, and White Rock
GVRHD FORECAST
ACUTE HOSPITAL BEDS

TITLE: ADULT (15-69) 1981

******************************
DATA USED:
INCIDENCE RATES: R003
POPULATION: P003
TRANSFERS: M023
PLANNED BEDS: B003

******************************

REMARKS:

THIS IS THE STANDARD FORECAST.

DATE PREPARED: 1 OCTOBER

*************
### ASSUMPTIONS USED IN FORECAST OF 1981 HOSPITAL BEDS

<table>
<thead>
<tr>
<th>AREA</th>
<th>INCIDENCE</th>
<th>POPULATION</th>
<th>OWN DAYS</th>
<th>TOTAL DAYS</th>
</tr>
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| TOTALS    | 1111      | 805950     | 895830   | 1064073    |

### TRANSFER MATRIX ASSUMED

<table>
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<th>PATIENT ORIGIN</th>
<th>AREA OF HOSPITAL TREATMENT</th>
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</tr>
<tr>
<td>Coquitlam</td>
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<tr>
<td>North Shore</td>
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**INFLOW ASSUMED** 19.0% OR AS BEDS: 518

**OUTFLOW ASSUMED** 0.2% OR AS BEDS: 6

**DISTRIBUTION OF INFLOW**
**BY AREA (PERCENTAGE)**

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**OCCUPANCY RATE ASSUMED**

PAEDIATRICS - 85% : MATERNITY - 80% : ADULT - 90%

THE OCCUPANCY RATE FOR THIS FORECAST IS 90%
<table>
<thead>
<tr>
<th>AREA</th>
<th>PLANNED BEDS</th>
<th>NEEDED BEDS</th>
<th>BALANCE</th>
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<th>NEEDED BEDS</th>
<th>BALANCE</th>
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<tr>
<td>North</td>
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</table>

**Explanation of Areas**

1. North includes the North Shore
2. Central includes Vancouver and Burnaby
3. South includes Richmond and South Delta
4. East includes Coquitlam, New Westminster, North Delta, Surrey, and White Rock
GVRHD FORECAST
ACUTE HOSPITAL BEDS

TITLE: GERIATRIC (70+) 1981

DATA USED:
INCIDENCE RATES: R004
POPULATION: P004
TRANSFERS: M024
PLANNED BEDS: B004

REMARKS:

THIS IS THE STANDARD FORECAST.

DATE PREPARED: 1 OCTOBER
### Assumptions Used in Forecast of 1981 Hospital Beds

#### Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Incidence</th>
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<td>35598</td>
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| Totals   | 5393      | 69150      | 372993   | 399103     |

#### Transfer Matrix Assumed

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INFLOW ASSUMED 7.0 % OR AS BEDS: 79

OUTFLOW ASSUMED 0.0 % OR AS BEDS: 0

DISTRIBUTION OF INFLOW
BY AREA (PERCENTAGE)

<table>
<thead>
<tr>
<th>Area</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>5.0</td>
</tr>
<tr>
<td>North Delta</td>
<td>0.0</td>
</tr>
<tr>
<td>Ladner</td>
<td>0.0</td>
</tr>
<tr>
<td>Richmond</td>
<td>0.0</td>
</tr>
<tr>
<td>Vancouver</td>
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</tr>
<tr>
<td>New West</td>
<td>15.0</td>
</tr>
<tr>
<td>Burnaby</td>
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</tr>
<tr>
<td>Coquitlam</td>
<td>0.0</td>
</tr>
<tr>
<td>North Shore</td>
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</tbody>
</table>

TOTAL 100.0

OCCUPANCY RATE ASSUMED

PAEDIATRICS - 85% : MATERNITY - 80% : ADULT - 90%

THE OCCUPANCY RATE FOR THIS FORECAST IS 90%
### GVRHD Bed Need Forecast for 1981

**Area** | Planned Beds | Needed Beds | Balance
--- | --- | --- | ---
Surrey  | 0 | 125 | -125
Ladner  | 0 | 0 | 0
Richmond | 0 | 31 | -31
Vancouver | 0 | 719 | -719
New West | 0 | 144 | -144
Burnaby | 0 | 91 | -91
Coquitlam | 0 | 0 | 0
North Shore | 0 | 105 | -105

**Totals** | 0 | 1215 | -1215

---

**Area** | Planned Beds | Needed Beds | Balance
--- | --- | --- | ---
North  | 0 | 105 | -105
Central | 0 | 810 | -810
South  | 0 | 31 | -31
East   | 0 | 269 | -269

**Totals** | 0 | 1215 | -1215

---

**Explanation of Areas**

1. **North** includes the North Shore
2. **Central** includes Vancouver and Burnaby
3. **South** includes Richmond and South Delta
4. **East** includes Coquitlam, New Westminster, North Delta, Surrey, and White Rock
GVRHD FORECAST
ACUTE HOSPITAL BEDS

TITLE: SUMMARY OF ALL AGE-SEX GROUPS.

DATA USED:
INCIDENCE RATES: R00X
POPULATION: P00X
TRANSFERS: M02X
PLANNED BEDS: B00X

REMARKS:

THIS IS THE STANDARD FORECAST.

DATE PREPARED: 1 OCTOBER
### ASSUMPTIONS USED IN FORECAST OF 1981 HOSPITAL BEDS

<table>
<thead>
<tr>
<th>AREA</th>
<th>INCIDENCE</th>
<th>POPULATION</th>
<th>OWN DAYS</th>
<th>TOTAL DAYS</th>
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**TOTALS**

|       | 1274 | 1135000 | 1447036 | 1683158 |

**TRANSFER MATRIX ASSUMED**

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<th>ND</th>
<th>L</th>
<th>R</th>
<th>V</th>
<th>NW</th>
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<th>C</th>
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</table>
INFLOW ASSUMED 16.5% OR AS BEDS: 735

OUTFLOW ASSUMED 0.2% OR AS BEDS: 8

DISTRIBUTION OF INFLOW
BY AREA (PERCENTAGE)

SURREY 5.1
NORTH DELTA 0.0
LADNER 0.0
RICHMOND 0.0
VANCOUVER 74.7
NEW WEST 10.1
BURNABY 0.7
COQUITLAM 0.0
NORTH SHORE 9.4

TOTAL 100.0

OCCUPANCY RATE ASSUMED

PAEDIATRICS - 85% : MATERNITY - 80% : ADULT - 90%

THE AVERAGE OCCUPANCY RATE FOR THIS FORECAST IS: 89.0%

PATIENT DAY FLOW STATISTICS

RESIDENT ACUTE PATIENT DAYS: 1447036
LESS OUTFLOW: 2650
PLUS INFLOW: 238770

NET GVRHD PATIENT DAYS: 1683156
ACUTE CARE BED REQUIREMENTS: 5183
### GVRHD Bed Need Forecast for 1981

#### Surrey Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Planned Beds</th>
<th>Needed Beds</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrey</td>
<td>416</td>
<td>475</td>
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</tr>
<tr>
<td>Ladner</td>
<td>75</td>
<td>0</td>
<td>75</td>
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<tr>
<td>Richmond</td>
<td>229</td>
<td>172</td>
<td>57</td>
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<td>Vancouver</td>
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<tr>
<td>New West</td>
<td>668</td>
<td>663</td>
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<td>Burnaby</td>
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<td>306</td>
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<tr>
<td>Coquitlam</td>
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<td>0</td>
<td>75</td>
</tr>
<tr>
<td>North Shore</td>
<td>456</td>
<td>468</td>
<td>-12</td>
</tr>
</tbody>
</table>

#### Total

**Total Planned Beds:** 5277  
**Total Needed Beds:** 5183  
**Total Balance:** 94

---

### GVRHD Bed Need Forecast for 1981 by Area

#### North Central Area

<table>
<thead>
<tr>
<th>Area</th>
<th>Planned Beds</th>
<th>Needed Beds</th>
<th>Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>456</td>
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</tr>
<tr>
<td>Central</td>
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<td>South</td>
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<tr>
<td>East</td>
<td>1159</td>
<td>1138</td>
<td>21</td>
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#### Total

**Total Planned Beds:** 5277  
**Total Needed Beds:** 5183  
**Total Balance:** 94