A SIMULATION MODELING TECHNIQUE FOR PROJECTING FUTURE EXTENDED CARE BED REQUIREMENTS

by

ELIZABETH KALLSTROM

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The University of British Columbia
1956 Main Mall
Vancouver, Canada
V6T 1Y3

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ABSTRACT

A simulation model was developed for the Greater Vancouver Regional Hospital District for the purpose of projecting future Extended Care Bed requirements. The model utilizes data which are not usually incorporated in such projections but which are critical for ensuring maximum accuracy of the projections. Length of stay and length of wait information are two such items. In 1980, the average length of stay in an Extended Care Unit was found to be 30.3 months and the average length of wait for admission to a unit was approximately 9 months within the G.V.R.H.D. The increase in the numbers of elderly in this population was projected to be 16,500 persons from 1981 to 1986 or a percentile increase from 11.7% of the total population to 12.4%.

In order to maintain a constant waiting period of 9 months, an additional 300 Extended Care beds were estimated to be required by 1986. The length of the waiting list, or the queue, would increase slightly under such conditions. An additional 2,200 beds would be required to eliminate the waiting period completely and to deplete the queue.

The effect of reducing the application rate was also investigated. Waiting period and queue length were very sensitive to such a change as evidenced by sharp reductions in both. The opposite was true when the application rate was increased; both waiting time and queue length increased considerably.

The effects of varying the proportion of activated on-hold applicants and the time interval for additions of new beds were also investigated.

The use of this model in forecasting Extended Care Bed requirements in the short term is discussed with a view to comparing these projection results to those of other forecasting methodologies employed in Canadian Metro regions. Future data requirements of the model are also discussed.

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CHAPTER I

INTRODUCTION

This is a discussion of several planning methodologies for projecting future Extended Care bed requirements in the Lower Mainland area. The study presents a simulation model developed for the Greater Vancouver Regional Hospital District. The model utilizes existing data, including statistics on length of waiting periods and length of stay in Extended Care Units (1). The model also attempts to assess the effect of availability of other services on the application rate for admission to the Extended Care Units (i.e., the measure of expressed demand on this system), and on the length of the waiting periods.

The structural changes in population growth in all industrialized countries will have profound consequences on demand for social services. The aging phenomenon of the Canadian population has not quite reached the proportions of other Western countries. The 1971 Census reported 8.1% of the Canadian population to be over 65 years of age, while the elderly in Sweden made up 13.7% of the total population, in England 12.4% and in the U.S. 9.9% (2).

In 1976 the proportion of the over 65's in Canada had reached 8.7% and was projected to reach 9.5% in 1981 and 12% in 2001. For the Greater Vancouver area, these figures were even more dramatic. The 1976 Census showed the Metropolitan region of Vancouver to have in its population one of the highest percentages of elderly in Canada; fully 10%, second only to Victoria with 15% of its population over the age of 65 (3).

The projected increase from 1976 to 1986 of the elderly in the Greater Vancouver Regional District (G.V.R.D.) is an additional 35,000 persons aged over 65 years, a 30% increase in ten years to 12.4% of the total population. The absolute increase in the very old group, those over 85 years is projected to be 3,500 individuals, or a 29% increase over 10 years (4). Statistics Canada has projected that the over 85 years of age group in British Columbia will double between 1976 and the year 2001 (5).

The progressive proportional increase in the older extremity of the population has important implications for the institutional sector of the health care system. The demand generated by this aging population is expected to increase both the number of hospital admissions and the average length of stay (6). The nature of this demand is also expected to shift towards long term health services, in response to chronic and degenerative diseases which require maintenance care rather than episodic illnesses which require interventions of a curative nature (7).

In addition, planning for long term health services to meet the needs of an increasingly elderly population is often hampered by the lack of suitable data bases regarding past experience and future expectations (8). Many of the elderly experience a gradual deterioration in functional ability and may therefore require both long term care services and extended care hospitalization in their life-time. With this in mind, the following section describes the Long Term Care Program and its various components.

1. Organization of Long Term Health Services for the Aged in British Columbia

On January 1, 1978, the British Columbia Ministry of Health announced the start of its Long Term Care Program (8). The Program encompasses, in whole or in part, services provided under the Health Act (1973), Hospital Act (1973), and the Community Care Facilities Licensing Act (1976) (9-11). In addition, a Home Support Service is provided.

The Public Health Units are the organizational structures responsible for the operation of the Long Term Care Program at the local level. A Long Term Care Administrator is based in each Unit and reports through the Director of the Health Unit to the Director, Long Term Care and Home Care.

Although Extended Care benefits became an integral part of the Long Term Care Program as of January 1, 1978, their operation continued to be governed by the Hospital Insurance Act Regulations (1977) (12). Extended Care hospitals are governed by Part I and Part II of the Hospital Act (1975) and Private Hospitals by Part II of the same Act. The Program, however, forms a cohesive structure providing a comprehensive spectrum of long term care services throughout the Province. Most of the elements of this system were present prior to 1978, but in a very fragmented form.

The philosophy on which the Program is based rests mainly on the premise that people are responsible for caring for themselves and their families as long as they are capable of doing so (13). The Long Term Care Program represents a continuum of services for persons unable to live independently because of health related conditions. It provides for a range of services, from Personal Care level at which clients are not in need of skilled nursing care, to Extended Care services where clients are virtually bed ridden. It is designed to promote the highest level of independence for its beneficiaries, with the aim of accessibility for all needy citizens in their own communities. Care is provided at home when it is feasible to do so.

The Long Term Care Program has a one-door entry procedure through the Health Unit office, which processes the referrals. These may come from the applicant himself or from his family, his physician or the facility in which he currently resides. The referrals are registered chronologically and are then assessed as to the best course of action for each individual applicant. In some cases no further action will be required but for others there will be a thorough investigation and a decision as to the level of care needed.

In these cases the standard assessment of each applicant considers functional, social and medical conditions which is recorded on a four-part assessment instrument, the Long Term Care Assessment Form (LTC 1) (14). When the applicant is deemed to require Extended Care, responsibility for the assessment procedure is shared jointly with Central Registry of Hospital Programs Division of the Ministry of Health.

The assessment procedure establishes both the level, (Personal/ Intermediate/Extended) and the type of care (Home/Facility), required by the applicant. A full description of the criteria for each level of care and some characteristics typical of applicants at each level are included in Appendix A.

An applicant assessed as eligible for Extended Care benefits may receive these services in the home in the form of adequate Home Support, if this is safe, or he may be waitlisted for admission to a public Extended Care Unit. Alternatively, such an applicant may be placed in a designated Private Hospital on an interim basis if the waiting period for the desired Extended Care Unit is very long.

Differences in eligibility criteria may influence placement of Extended Care clients. Any individual who is a Canadian Citizen or a Landed Immigrant and has resided in the Province for at least twelve consecutive months is entitled to become a beneficiary of the Long Term Care Program, but applicants for Extended Care Units become eligible after three months residency.

Extended Care Units provide 24 hours of professional nursing supervision in addition to a multi-disciplinary staff of physiotherapists, occupational therapists, social workers, dieticians, pharmacists, and attending physicians. They provide an active program for those who require long term institutionalization but not the services of an Acute or Rehabilitation hospital (15). Medical eligibility criteria are based mainly on the ambulatory ability of the client.

In addition to the conventional facilities described above, Vancouver provides a new type of service through its two Geriatric Assessment and

Treatment Centres at Mount Saint Joseph's Hospital and Banfield Pavilion. In order to properly care for the elderly who suffer from multiple pathologies, these centres provide an inpatient unit, a Day Hospital program, and an Outreach component with full diagnostic capabilities operating out of the attached Acute Care hospital.

Although the applications and waitlisting for admission to Extended Care Units are processed by the Central Registry of Hospital Programs Division, which ensures that waitlist seniority is purely chronological and Province-wide, the majority of applicants wish to enter a facility in their own municipality of residence. The Lower Mainland constitutes a unified geographical entity for Extended Care admissions, with a relatively free flow of applicants across municipal boundaries within the G.V.R.D. (22% of admissions), but very little movement across regional district boundaries (2%) (16). The Regional Hospital District also has the mandate for hospital construction, including Extended Care Units.

2. Organization of the Greater Vancouver Regional Hospital District

The Greater Vancouver Regional Hospital District is charged with planning and establishing hospital facilities for the region. Construction costs of Extended Care Units are met by the Hospital District and Hospital Programs Division on a 60/40 cost-sharing basis (8). However, operation of Extended Care Units is the sole responsibility of Hospital Programs Division.

The purpose of a regional hospital district is to establish, construct, enlarge, and maintain hospitals and hospital facilities and to grant aid for such establishments' construction, enlargement, and maintenance. The district may also raise in any year, by making provisions in its budget, an amount not exceeding the product of one quarter of a mill on the assessed value of land.

The Regional Hospital Advisory Committee of the District

> ... shall, when requested by the Board, review the hospital projects proposed by the boards of management of the hospitals in the District and recommend regional programs for the establishment and improvement of hospitals and hospital facilities in the District for presentation to the Board for approval.

The Hospital Advisory Committee determines priorities for the location of additional beds and related diagnostic/treatment facilities, and studies and promotes, among hospitals, changing patterns of care and greater cooperation in pooling services. The committee further reviews all capital grants-in-aid from the 1/4 mill fund.

The terms of reference for the G.V.R.D. Board's Hospital Committee state that the Committee will consider recommendations made by the Hospital Advisory Committee from a political and overall financial point of view. The committee then makes recommendations to the Board for total financing commitments and approvals for specific hospital projects (8).

3. Statement of the Problem

The purpose of this thesis is to outline a methodology for projecting future Extended Care bed requirements for the geographical entity G.V.R.D. The simulation model developed for this purpose utilizes information which is not usually incorporated in such projections, but which is critical in ensuring their maximum accuracy. Length of stay and length of wait information are two of the most important data items in projecting bed requirements (16); by themselves the number of existing beds and the number of patients on waiting lists give incomplete information on which to base projections.

The first chapter of this thesis is an Introduction outlining the setting in which the study takes place, and the following chapter contains a review of the literature concerning the extent of the aging phenomenon in our society and the various approaches to meeting the perceived needs of the elderly. Chapter three describes the method used in this study - ie, the simulation model - and outlines the data requirements along with a flow diagram of the logistics of the Extended Care system in British Columbia.

Chapter four presents the results of the computer simulation experiments and in Chapter five, the findings are compared with the alternative methods in common use and suggestions are made for improvements in future research in this area.

CHAPTER II

LITERATURE REVIEW

1. The Greying of Canada

More than 75% of the elderly in Canada are afflicted by some type of chronic illness. Although (in 1976) they constituted only 9% of the population, they accounted for 15% of all physician services and 35% of all patient days in hospitals - this is expected to increase to 45% by the year 2001 (17). Perhaps we are entering a period when there will be social disadvantage in increasing the average life span because of the onerous cost of providing for the larger number of seniors. On the other hand, it may become possible to increase - even to age 200 - the healthful and productive years by investing in basic studies of the aging process, by eliminating major killers such as circulatory and neoplastic diseases, by pharmaceutical, dietary, and immunological manipulations, by reducing body temperature, and even by re-instituting repressed gene function (18). Improvements in medical science must not simply prolong life; they must also add health to the resulting years. There must be more emphasis on prevention of illness, as it may not be economically viable in terms of resource consumption to offer certain expensive health care resources to an elderly individual. Difficult decisions must be made in regard to what kinds of medical facilities should be made available.

Currently, Canada institutionalizes more of its elderly than any other Western nation. Although most of the elderly in Canada maintain their own households: 64.3% own their own homes compared to 61.8% of the under 65's; 8.7% live in some form of collective housing, compared to only 1% of the population under 65 years of age. The elderly do, however, represent 45.2% of all persons living in collective dwellings, which include nursing homes (19). In 1976, for example, 8% of the elderly were in institutions in Canada compared to 6.3% in the U.S., and 5.1% in the U.K. (20).

Dependency ratios measure the relative burden on the work force of increasing dependent segments of the population, and are an important factor in calculating future health care needs. The total dependency ratio measures the size of total dependent population (those 0 - 19 years plus those over 65 years) relative to the size of the working population, and the old age dependency ratio gives an index of the generational balance between retirement age and working age (17,18). In the year 2031 the dependency ratio for the 65+ group is expected to be greater than the dependency ratio for the young, the 0-19 group. The total dependency ratio will gradually decrease from the present ratio until the year 2011, and then it will slowly rise again (21).

For the G.V.R.D. the old age dependency ratio in 1976 was 18.1%, in 1981 it was 19.1%, and it is projected to increase to 19.8% by 1986. The highest ratio among individual municipalities withing the G.V.R.D. was 30.1% for New Westminster in 1981.

Another factor which must be included in the new health care equation is the ratio of elderly women to elderly men, which has increased substantially since the beginning of the century. In 1901 there were 1050 men to every 1000 women, while in the 1976 Census there were only 777 men to every 1000 women. The greater increase in life expectancy among women and the unequal sex distribution of immigrants between the years 1931 and 1948 account for the change in this ratio. Almost half of all elderly women are widowed while widowers account for 15% of the elderly men. Only 39% of women are married and live with their spouses, but 74% of the men fall into this category. The sex ratio of elderly persons has important implications for planning facilities. The proportions of beds allocated to each sex will affect the respective length of time women and men will have to wait for a vacant bed.

Changes in the structural composition of the population affect both demand for health care services and the productive capacity of the economy. The relative burden of health sector costs on the total economy has an affect on public planning for future levels of service provision. Perhaps there is a cost-threshold beyond which public support for the current direction of costly institutional emphasis of care for the aged will wane. Beyond this threshold, it may be necessary to consider more innovative types of care.

There are estimates which calculate the cost of caring for the elderly at three times the cost of caring for the young (22). It may become necessary to encourage changes in attitudes towards the elderly and to foster an emphasis on family and community responsibility in order to reduce the expectation that all support should be derived from government programs.

> Somehow, the value system of the HEALTH CARE ORGANIZATION will have to be revised so that the care of the chronically ill will be seen as equally rewarding as the cure of acute conditions. The need for this revision of the value system is already pressing and will become more so as the percentage of the aged in Canada's population increases (23).

2. Approaches to Meeting the Problems of the Elderly

The current emphasis in Canada on institutional care for our elderly citizens and the future projected utilization patterns of the elderly population have enormous cost implications. The historical focus on health services as provider of care for the elderly may not be entirely appropriate for the growing numbers of elderly in most industrialized nations. Perhaps long term care for the aged is a social problem of which health is but one component (18).

A. Development of Long Term Care Programs in Four Industrialized Nations

The following is a brief description of the development of health services for the elderly, often as a component of the provision of social security programs.

i) Great Britain:

The elderly of Great Britain make up 13.5% of the entire population, and comprise a substantial proportion of the needy (24). The British have historically had a commitment to provide social and health services within the community, with institutional care as a last resort only. There is an inherent belief in Britain that the elderly are happiest in their own homes in the familiar community where they have their roots. There has always been a shortage of chronic care beds, but conviction persists that care in the home is less costly than care in facilities (although this contention has never been unequivocally established).

The development of a National Health Service in 1946 occurred as a tripartite orgranization of General Health Services, Hospital Services, and Local Health Authority Services. It is noteworthy that the hospital-based specialists developed strong hospital-based programs with emphasis on the use of high-level technology in diagnostic assessments and supported by a well developed home-care program in the community. However, under the original National Health Service the link between these two services and those elderly individuals who had little rehabilitative potential and could not be cared for in the home, i.e., those who needed more custodial-type long term care, was very weak. Under the 1974 reorganization of the National Health Service, the three divisions were united under one authority, and planning for an organization of services took place at a local district level with the involvement of all health professionals.

The National Health Service has the highest degree of central planning of any health service in the industrialized world. However, the major difficulty in this system has been cost-containment, which can only be solved by restricting access to the system (25). The dominance of the geriatrician in the system means that the services provided for the elderly seem very medically-oriented. The British system has queuing as a way of life, with a tradition of everyone patiently waiting for one's turn for its limited resources. This is not generally acceptable in North America.

ii) Sweden:

Sweden has been able to concentrate on domestic social programs in the 170 year absence of war. But with universal old age pension and virtually free medical care, the almost 14% of the population who are elderly constitute a heavy tax burden (26).

Health services are administered locally through county councils which are responsible by law to provide health care for their population (27).

Nursing home care has doubled between 1960 and 1972, while acute care beds have only increased 10% in the same time period. The country has 20 geriatric ward beds in acute care hospitals per 100,000 population, mainly for diagnostic purposes. These comprise 10% of all

Long Term Care beds. Active rehabilitation nursing home beds make up 30% of the total long term care bed complement and the remaining 60% are in chronic maintenance nursing homes (26).

In spite of very generous long term care resource allocation in this country, waiting lists for facility placements are long. The Swedish experience is very similar to the situation in the G.V.R.D.; 30% of the wait listed clients occupy Acute Care beds, mainly in medical/surgical wards, 34% are in their own homes and the rest are in other facilities. Fully 20% were inappropriately placed in a long term care facility and it was estimated that 3.5% could be discharged home.

The lengths of stay distribution in this chronic care system showed that 20% of the clients stayed 10-19 years, 11% stayed 5-9 years, 29% stayed 3-4 years, and 58% less than 2 years.

iii) United States

The depression of the 1930's was a terrifying shock that altered the American view of social security and welfare somewhat, since there had never been a unified social-welfare tradition in the United States.

> "This economic crisis had produced people in need despite industry and individual initiative." (24)

The New Deal planners envisioned the assumption of responsibility for public welfare by government. Thus, the Social Security Act of 1935 established a precedent for future Medicare legislation. Health care for the aged in America was defined as financial assistance in meeting the costs of medical services delivered under existing arrangements but did not address alternative means of caring for the aged.

The 1965 Medicare and Medicaid amendments to the Social Security Act provided a compromise between those who wanted less government interference in health care and those who wanted wider population coverage. Medicaid requires a means test and therefore follows a social welfare tradition, with services completely free of charge. Medicare, in contrast, is a universal program which requires the beneficiary, i.e., anyone over the age of 65, to partially pay for the services. Prior to this amendment there was little change in the utilization rate of health resources by the elderly although since 1935 the proportion of elderly in the population had grown substantially. Perhaps one explanation for the failure of utilization rates to match the growth in the elderly population was that the trends of health care were towards services not appropriate for the elderly population and often located so as to minimize accessibility. At the same time, the cost of services was growing rapidly (28). Medicare has had the effect of increasing and expanding the acute care capacity of hospitals. Nursing home care is not covered unless it is a Skilled Nursing Facility and then only for the limited time specified by the Act. Instead, acute hospital stays have been encouraged.

iv) The Canadian Situation:

Daniel Baum characterizes the Canadian way as consisting of more institutions, and he describes the Canadian attitude towards the elderly in this way:

> In a very real sense, they are encapsulated and warehoused for death. They are removed from the community, and the community accordingly does not have to see either old age or death (29).

Canada has, as mentioned earlier, a higher rate of institutionalizing its elderly than almost any other industrialized country. One of the most important explanations for this is the bias in the payment mechanism of our health insurance scheme (20). Home care services were not insured simultaneoulsy with hospital care as was done, for example, in Britain. Health professionals also tend to foster institutionalization.

Additional factors favouring institutionalization of the elderly include severe climate and rural geography. Great distances and lack of health services in rural areas, coupled with almost non-existent transportation systems, necessitated hospitalization of the aged, particularly in winter time (30). Canada has also had, historically, a general tendency to institutionalize all its "deviants".

B. Sociology of Institutionalization

Popular attitudes towards institutionalization have been heavily influenced by Erwin Goffmans' theory of the 'sociology of total institutions', based mainly on data gathered from mental institutions. The basic tenet of the theory is the pathology of bureaucracy of organization, whereby

> ... the institution actively participates in reducing the resident to a total lack of power. This ultimately results in iatrogenic diseases of institutional life; dependency, depersonalization, and lack of self-esteem ... and eventually the disruption of the individual's personal economy of action (31).

However, theories concerning institutionalizing the elderly should perhaps start with the non-institutionalized elderly, who often experience poverty, isolation, and physical disability. If one compares the mentally disabled institutionalized to the healthy, middle-class, non-institutionalized elderly population, one arrives at different conclusions than would be obtained from a comparison with the mentally disabled elderly who are not hospitalized. Perhaps the institutionalization of the elderly does not represent such a radical disruption of their previous lifestyle and consumption pattern as has been assumed. Perhaps the dominance by staff and subordination of residents in institutions only reflect their social relationships in the larger society, where the elderly have become a proletariat and a dependent group, who, like children, have very little opportunity to participate in society and influence their own condition.

In a secondary study of the data collected by the 'Aging in Manitoba' study team, it was found that the most important predictors of perceived well-being were: perceived health, autonomy in choosing residence, contact with close friends, and perceived future economic well-being (32). Institutions for the elderly are rarely designed to meet the needs in these areas.

During the early period of industrialization, the policy with respect to the elderly was to discourage dependency on the public payroll, and the 'poor-houses' were made as unpleasant as possible to make individuals volunteer for the labour force. Post World War II policy, on the other hand, has been one of relief and social insurance, and the medicalization of institutions has made public assistance to the elderly acceptable to the middle-class. Institutional care of elderly parents has become part of the bureaucratic organization of the middle-class life cycle, so that affluent children can shift the responsibility of care for their aged and ailing parents to the state (32).

These days it is in vogue to criticize the institutionalization of any group. Such criticism usually attacks the very nature of institutional life itself rather than the 'quality of care' in institutions. Even governments have been eager to fuel such opinions in their attempts at swaying the public towards the less costly, non-institutional care for those in need.

Projections of future institutional utilization patterns by the elderly have reached chilling conclusions. As noted earlier, the over 65 group is estimated to account for 50% increase in the number of patient days by 1986 and a doubling by 2001 (2). The proportion of total patient days represented by the elderly was 35% in 1971 and it is estimated that it will account for 39% in 1986 and 43% in 2001. If current trends continue, at the turn of the century, approximately half of all health dollars will be consumed by the aged, due mostly to increases in institutional costs.

A series of simulations were run to test outcomes in terms of costs as a fraction of total output and cost-per-capita in a complete economic-demographic system (33). Canadian hospital services data for 1969 were used together with Ontario data on physician services for 1971 in predicting various cost-outcomes as a result of different population changes. The total health care function was described as:

$$H_t = \sum_{i=1}^{2} \sum_{j=0}^{109} h_{ij} N_{ijt} + \sum_{j=15}^{49} f_{jt} N_{2jt}$$

Where:
H = total health care expenditure
h = health care cost per capita
N = population
f = fertility factor
i = sex
j = age
t = time

Several simulations were conducted based on different input assumptions, such as changes in fertility rates and migration patterns. High fertility rates result in a larger proportion of young people, the resulting overall higher dependency ratio means that health care costs account for a larger fraction of the total output.

A low fertility pattern results in a higher proportion of old persons in the long run with a slight increase in the fraction of total output allocated to health. The low fertility rates of 1969 also result in more than a 10% increase per capita costs of health care.

Net migration equal to 1% of the domestic population results in a fall in average age and a rise in dependency ratio. The long term effect is to increase the fraction of total output alloted to health care and to decrease per capita health care costs.

The pattern which emerges from these simulations suggests that large increases in health care costs over a single decade are more likely to be the result of changes in quality of services provided and service mix, rather than a result of population changes. However, changes in the population structure do affect costs of health services and changes in fertility rates have more profound effects than changes in migration rates.

C. Current Issues in Geriatric Care Provision

(i) A Problem: Acute Care Bed-Blocking:

One of the most high-profiled problems of institutionalization involves 'bed-blocking' by elderly long-stay patients in acute care wards (34). When members of the public are informed that new admissions to hospitals are delayed or elective surgery cancelled because of bed-blocking by long-stay patients, they perceive this as a real threat to their own health (35). Health professionals practicing in the acute care setting see such bed-blocking as a waste of acute care resources and not as a rewarding care experience. Long waiting times and long waiting lists for admissions to Extended Care beds also contribute to the enormous pressure for more Extended Care hospital construction to reduce the burden of the long-stay patient on the acute care hospital.

In Manitoba, this problem has been studied extensively for Metro Winnipeg acute care hospitals (36). The Winnipeg area experienced a major expansion of long term care facilities in the 1970's, with 200 new beds opened during a five-year period. Insured home care programs were also expanded. Yet, acute care hospital utilization by the elderly, particularly the over-75 group, increased during this period. The increase was particularly marked in the very-long stays, ie., the 90+ day stays, and was not due to any changes in illness mix or multiple pathologies as the samples were standardized on the Laspeyres-type case mix index (37). The authors concluded that the major factor in causing this acute care back-up was the transfer process of patients to nursing home.

There is also concern about the fate of these 'bed-blocking' patients in holding wards, where they may deteriorate both mentally and physically due to lack of proper rehabilitative programming. The negative attitudes of hospital personnel may further damage their fragile self-esteem and leave them lonely and isolated (36).

The Hospital Programs Division continuously monitors long-stay patients in acute care beds in all hospitals in British Columbia. During 1980, approximately 11% of all acute beds in the G.V.R.D. were occupied by patients no longer in need of acute treatment (38). The majority, 60%, were assessed as Extended Care eligible. Other surveys during 1980 found the levels to be 13.5% (39), and 16% (40). A survey conducted by the G.V.R.D. in September, 1980, found that, on average, Long Term Care patients occupied Acute Care beds for 70.7 days, again with patients who were Extended Care eligible staying the longest, approximatley 80.1 days (16). The various approaches which have been suggested, and sometimes attempted, to alleviate this situation are discussed in Chapter V.

(ii) A Solution: Day Hospital:

Future hospital utilization predictions and corresponding cost-projections have demonstrated the need to re-examine the present emphasis on institutional care, and to change the orientation of the Canadian health care system away from hospitals as primary care givers for the elderly. Many different approaches have been postulated: Day Care and Day Hospital services, respite admissions, and preventive care in different forms.

Historically, Day Hospital services developed in Britain initially in the field of psychiatry and later in geriatrics (41-43). This type of hospital service is slowly gaining ground on the North American continent and is designed to serve two types of patients: long term care patients who attend as an alternative to institutionalization, and short term patients on acute care hospital replacement programs (44,45). The major function of a Day Hospital is to maintain the level of functioning of the elderly population and thereby delay, or even prevent, future hospitalization, as well as prolong their stay in their own home or reduce the number of days spent in acute care hospitals (46-48).

One of the most successful Senior Day Health Centres in the United States is the demonstration project On Lok in San Francisco's Chinatown. On Lok provides the usual array of hospital services as well as an Outreach program. The clientele represents a very narrow medical spectrum; the Centre does not accept clients who are totaly non-ambulatory or exhibit behavioural problems, nor clients who can function on their own (49).

Much debate has been centred on the methodologies of cost comparisons between Day Hospitals and inpatient nursing homes (50-52). One approach to the problem would be to randomly assign Day Care applicants to treatment and no-treatment groups and later record dates of hospital admission and death. It might be expected that the treated group would have more years of life but fewer years of hospitalized life, on average (53). Such a study design has been utilized in the National Centre for Health Services Research (54). The results of these studies will not, however, become available for several years.

Locally, there are two Day Hospitals in operation at the present time. The Banfield Pavilion Day Hospital opened on March 18, 1980, and has a Day Hospital component of 20 spaces (15 on-going and 5 early assessments) and an Outreach program, while the inpatient function is coordinated with the Banfield inpatient unit. Mount Saint Joseph has all three components and opened its Day Care function with 15 spaces October, 1979, and an inpatient capacity of 20 beds in January, 1980. It also has an Outreach program. The eligibility requirements are very strict at this unit, which will not admit anyone who does not exhibit psychological disturbances.

D. Methods Used to Project Future Bed Requirements

(i) Assessment of need:

The needs of a segment of the population are often defined in terms of resources already present, and planning for future services becomes a simple extrapolation exercise from present utilization rates to parallel projected population increases. Large scale epidemiological surveys of a sample of the target population are costly and time-consuming, so that rational planning must be attempted based on use of existing data (55,56). Analysis of the characteristics of applicants to Long Term Care facilities in Kingston, Ontario (57), reveals that these elderly to fall into the following categories:

- 15% to special 'demented' homes
- 18% to Extended Care hospitals
- 23% to Intermediate Care facilities
- 11% to Personal Care homes
- 33% to Home Care services

The application rate was 2.7% of the over-65 population. However, the actual admission rate was considerably lower.

Areas of expressed need among elderly persons include transportation, housing, health care, and home care. However, these needs are usually described by the staff and professionals who often come from different socio-economic strata than their clients and tend to name the services they are responsible for as the most important to their elderly clients, as well as to overestimate the need for these services (58).

An extensive field survey of the elderly population and the resources available to meet them was undertaken in 1971 in Manitoba (59). Needs of the aged were assessed in nine areas on a one-to-five point scale designating highest and lowest need intensity level. From this survey instrument a need profile was constructed and a mirror profile constructed of the resources' ability to meet these needs (60,62). The survey attempted to relate these two in such a way as to enable identification of discrepencies, overlaps, and alternatives at local, regional, and provincial levels.

Both facility populations and those living independently at home were sampled. A profile techique was developed to produce a graphical display of histograms based on mean responses. The needs profile was fitted with the resource profile at comparable aggregate levels and the degree of fit was determined. The survey instrument solicited individual responses as to perceived degrees of need rather than attempting to establish an objective measure of need, or functional level as is possible with the British Columbia assessment instrument LTC 1 (14).

(ii) Linear Extropolation Methods:

In order to allow for the variation in the use of health services by the elderly, an attempt was made to derive an age/sex related formula for a more accurate calculation of geriatric bed requirements (63). The calculations were based on the assumption that only those who require hospitalization were waitlisted and subsequently admitted: ie., that the demand accurately reflected medical need in the District.

The number of inpatients and those on waiting lists were classified by sex and age groups (65-74, 75-84, 85+), and a bed rate per 1000 population at-risk in each sex/age group was calculated (number of inpatients plus waitlisted applicants). The projected population increases for each group were multiplied by the bed rate and summed, and a total projected bed rate was calculated for each year projected. It is noteworthy that this formula for estimating bed requirement does not take into account either length of stay in the hospital or length of wait. The formula is based entirely on present utilization patterns.

a) Toronto Formula:

Based on a cross-sectional survey of all Long Term Care facilities in the Metro Toronto Region, the Hospital Council proposed a method for calculating future geriatric bed requirements (64). This formula was based on the aggregated age group of the over-65 years of age. Waiting list data were not available, so it was assumed that 10% of all patients waitlisted resided at home while 90% were inappropriately placed patients in various institutions and thus waitlisted for transfer. Calculation of projected demand was based on participation rates and adjusted demand.

$$\text{Demand} = \text{participation rate} \times \text{population projection}$$

$$\text{Participation Rate} = \frac{\text{Adjusted Demand}}{\text{Catchment Area Population}}$$

$$\text{Adjusted Demand} = \text{Current Number of Inpatients} - \text{Inappropriately Placed Patients} + \text{Current Patients to be Transferred} + \text{Patients at Home}$$

(calculated for each level of care). Again, length of stay and length of wait are not considered in the calculation, and the estimate is based on actual utilization.

b) Ottawa Formula:

Yet another study of needs for long term health services for the elderly, this time in the Ottawa-Carleton area (65,66), produced recommendations based on very inadequate data. Projected utilization for various types of Long Term Care beds was calculated as:

$$T_0 \text{ beds} \times 1 + \left[\frac{T_1 \text{ population} - T_0 \text{ population}}{T_0 \text{ population}} \right]$$

Where: T_0 = the current year
T_1 = the projected year

The projected utilization was then compared to the Provincial guidelines for bed allocations and recommendations were made according to resulting surplus or shortage (67). This method is particularly surprising in view of the fact that this study group had available to them data on number of applicants waitlisted and length of wait. Data were available by sex and level of care.

It is typical for all planning of geriatric long term health services to be based on simple utilization data, sometimes added to waitlist data, and at best partitioned by sex and finer age groups (63). Bed requirements are then projected as a bed rate per 1000 population over 65 year of age. In 1975, a Swedish survey of all Long Term Care facilities provided exhaustive information on every possible topic, including sex/age distribution, length of stay in institutions, number of applicants waitlisted and place of residence of waitlisted clients. Length of wait was not available (27). However, when recommendations were made, bed requirements were not calculated on the basis of length of stay (and length of wait); neither was age-distribution or sex considered in the planning formula.

c) Manitoba Method:

The field survey of the elderly population in Manitoba in 1971 produced rather different and very interesting statistics (60-62). The survey sampled both the general population of elderly persons and those living in residential facilities. The following information characterizes the functional needs of the aged in the Metro Winnipeg area:

General Population %	Functional Need %	Facility Population %
1.3	needed help getting in and out of bed	18.0
8.4	needed help getting out of doors	26.0
0.4	needed help with feeding	8.7
3.9	needed help with washing	39.1
8.5	needed help cutting toe-nails	59.4
3.3	needed help with taking medication	46.0
5.5	received nursing care	47.4

Furthermore, in a typical month in 1971, of those 65 years of age and over:

- 9.5% lived in a facility
- 17.4% attended a club
- 4.0% received service from an organization
- 9.1% received service from government health agency
- 4.1% received service from non-government health agency
- 10.1% received service from government social agency
- 2.8% received service from non-government social agency
- 3.2% received service from 'other' agency (eg., recreational, educational).

Metro Winnipeg also had statistics on number of persons waitlisted for each level of care and average estimate of length of wait for facility placement, as well as degree of inappropriate placement in acute beds (68,69). Although length of stay and length of wait statistics are not incorporated in planning bed requirements, the survey data gives a good data base for estimating level of need for future services. The provincial guidelines for bed allocations are 90 'Personal Care Home' beds per 1000 population 70 years and over, plus 1.2 Extended Treatment and Rehabilitation beds per 1000 general population. It is recognized that these suggested provincial bed rates may not be equally applicable in urban and rural areas.

d) British Columbia - Long Term Care Formula:

The suggested bed allocation guidelines for geriatric health services for British Columbia take into consideration the differential use of health services by the very old age group, particularly those aged 85+ (70). The proportion of the aged assessed to be in need of services, partly based on a survey of Long Term Care Admissions in one urban and one rural Health District (71), were as follows:

- 5% of the 65 - 74 group
- 20% of the 75 - 84 group
- 50% of the 85 + group

The fraction of the population in each group who would need care would then be:

- 5% of the 65 - 74 pop.	= X
- 20% of the 75 - 84 pop.	= Y
- 50% of the 85 + pop.	= Z
Total 65 + needing care	= W

Of these (W) fully 50% could manage with the aid of Home Support, 30% would need institutional care at Intermediate Level, and 20% at Extended Care Level. Therefore, the calculation of required health services for the over-65 group is:

Home Support	: 50% x W = a% of the 65+
Intermediate Care	: 30% x W = b% of the 65+
Extended Care	: 20% x W = c% of the 65+

Total proportion needing care = d% of the 65+ (ie., 'W')

Note that this does not give a breakdown of proportion in each level for the finer age-groups. The overall percentages arrived at by this calculation were 6.8% of the 65+ age requiring Home Support, 4% requiring Intermediate Care placement, and 2.7% requiring Extended Care admission.

e) British Columbia - Hospital Programs Division Formula:

Hospital Programs Research Division estimates future Extended Care bed requirements by calculating the number of beds needed on the basis of applicants waitlisted, number of admissions per month, and the proportion of refusals from the waiting list (72).

Number on Waiting List	= A
% refusals from this list	= B
Number of waitlisted patients admitted	= C
Number of admissions per month	= D
Length of 'suitable' wait (months)	= X
Number of beds required immediately	= Z

$C = A - B$ and $Z = C - XD$

Therefore, total number of beds required are:

Total Beds = current bed complement + Z

From this a bed rate per 1000 65+ age population is calculated and applied to projected future population increases to give the estimated number of Extended Care Beds needed. The following is an example with actual numbers:

A = waiting list in November 1979	= 1291
B = % refusals = 30%	= 387
C = number of admitted waitlisted patients	= 904
D = number of admissions per month	= 75
X = length of suitable wait = 3 months	

The number of beds required immediately:

$Z = C - XD = 1291 - 387 - 3 \times 75 = 679$

The current bed complement was	:	2446
immediately required	:	679
Total beds needed	:	3125

Population 65+ (1979) = 122,465

$$\text{Bed rate} = \frac{3125}{122,465} \times 1,000 = 25.5 \text{ per } 1,000 \text{ 65+ population}$$

The 1986 population projection used in the calculation was: 65+ = 140,627 multipled by the 25.5 per 1,000 bed rate = 3586 total beds required. By 1979, it was assumed the G.V.R.D. would need a total of 3586 Extended Care beds, of which only 2446 already exist, and by subtraction,therefore, 1140 new beds would be required .

f) Summary of Linear Methods Limitations:

Without employing the more complex simulation techniques, forecasting future bed requirements can only incorporate a few static variables such as number of patients occupying existing beds, number of patients on waiting lists, and number of projected elderly in the population at a future point in time. Not included in linear-type forecasting methods are the dynamic variables describing the flow in and out of the system including also the transfer across the system. Such variables would include length of wait, application rate, length of stay, and discharge rate, as well as length of stay of transfer patients. In order to incorporate such variables and to describe their complex interrelationships, more sophisticated forecasting techniques are required. Simulation modeling makes it possible to describe these intricate relationships and to project future outcomes from complex systems with large numbers of variables.

(iii)Simulation Techniques:

A systematic approach to planning in the health care field is more easily made possible through applying the methodologies of systems analysis. Mathematical modeling can thus forecast demands on the system and the resources available as well as the resulting shortages and social impact of such shortages.

A multi-purpose simulation project in the Greater Vancouver Regional District brought together many seemingly unrelated fields (73). The Health Group constituted one component of this macro-modeling group. Three directions for modeling were evident:

a) Qualitative modeling:

This technique describes the effect of various health policies. Ten variables were interrelated in pairs in a Delphi-like manner. The results from such simulations showed the health care system to be an unstable one.

b) Descriptive modeling:

This technique describes the existing system and provides a useful technique in short-run planning. The variables here were based on historical patterns of referral, diagnostic and therapeutic behaviours of physicians.

c) Prescriptive modeling:

This technique considers prescribed norms for regulating health care resources required to treat certain illnesses. The model is interactive and allows priorization of patient treatments and some resource substitutions.

The maximum time-frame for a descriptive model is approximately ten years, as major technological discoveries and changes in clinical practice and social behaviour may take place (74). It is also important here to choose the optimum time-scale for the model. For example, a year is a convenient time span from an availability-of-data perspective, but it is too long to reflect immediate effects of resource shortages. A more suitable time-frame of a week to a month, which would be more representative of time delays between service requests and treatments, is unrealistic as no data are available.

The prescriptive model is based on four sub-system components:

Disease Generator
Priority Streaming
Resource Allocation for Treatment
Evaluation of System Shortages (75)

Demand for health services is greatly influenced by the awareness of their availability. However, utilization may be distorted by an existing shortage in facilities causing back-logs and long waiting periods. The data requirements for this type of model include:

- population projections by age and sex
- disease incidence rates (aggregated disease categories)
- priority distribution of treatement of each category
- health resources (physician types, nurses, beds)

The specific data items included in this model for estimation of bed requirements were: rates of hospitalization per 100,000 population, and average length of stay and incidence rates per 100,000 population. The number of days per incident for each disease category was derived. The number of bed days available per year was calculated by multiplying the category. If a resource shortage exists, substitution of alternative resources takes place. If this is not permissible, a higher priority is assigned in the next time period.

Priority assignment ranks disease categories and is based on a probability distribution for each disease, so that X% are of class 1, Y% of class 2, Z% of class 3, W% of class 4. Untreated cases either take on a higher priority in the next time period, or they result in a lower priority if death or spontaneous recovery takes place (76).

Evaluation of the performance of the health system as modelled suffers from lack of a relevant measure of the outcome of resource deployment. In other words, the costs expended are not related to the value of the benefit accrued to the individual from these expended resources.

The prescriptive model was run under four different assumptions of population growths (zero and normal and resources growth (no growth and 2% growth), and in all cases the system eventually broke down due to severe resource shortages (75). The zero population growth assumption results in a shift in age structure of the population with the resulting morbidity shift from acute to chronic diseases and a corresponding shift in resource utilization. The decreased fertility rate means decreased obstetrical visits and decreased paediatric care. The long range effect would be a change in the resource mix of medical specialties.

d) The Present Model

As health sector problems are becoming increasingly complex, an approach which provides system objectives to the policy-making process becomes increasingly important for problem-solving in the health sector, as it has been for a long time in the private and industrial sector.

Simulation techniques have also been applied in the determination of optimal size of a hospital. Relevant variables for such a technique include number of beds, occupancy and average daily census of the hospital (78). In this manner, the optimal number of beds can be calculated in order to achieve maximum occupancy in a given hospital unit, eg., a medical/surgical unit (79).

Simulation modeling has been utilized to describe various hospital sub-systems such as an outpatient clinic, the clinical laboratory, the surgical unit, and the maternity suite (80). A variety of parameters can be studied in this manner, eg., occupancy rates, admission rates, and varying the lengths of stay. Such modeling techniques are designed to allow the most cost-effective and efficient use of any hospital department.

However, modeling exercises on a scale between the macro and the hospital sub-system, have been very scarce. Modeling techniques to determine bed allocation forecasting have not been reported in the literature, at least not for the projection of Chronic Care/Long Term Care bed requirements.

The present study is an attempt at describing the Extended Care system with simulation modeling techniques. The model is mostly descriptive in nature. It is a short run forecasting method designed to predict the effects on the length of waiting time of different methods of intervention. The interventions in this situation consist of varying numbers of new Extended Care beds added to the system and different levels of demand, ie., application rates.

Any behavioural changes among the target population or their care givers are not included in this model, as no quantitative information is available on this variable. It is however, recognized that additional "supply" of services does generate additional demand and these changes may be considerable.

CHAPTER III

METHODS

A short and simplified flow diagram of the movement of patients through the British Columbia Extended Care system is given in Figure 1. A more detailed version of this diagram is included in Appendix B. The shorter diagram forms the basis of the simulation model described in this study. The individual steps shown here make up the input to the model and describe the data items and their inter-relationships in the system.

The shorter version was chosen as the model on the basis of availability and accuracy of data. However, in some instances, the more detailed data were not of consequence for the simulation model and were therefore omitted.

1. Simulation Model Flow Diagram

The definitions and the steps in the flow diagram are:

Target Population: The elderly make a greater demand on Extended Care than do younger people (2). The 'very-old' group, ie., those persons who are over 85 years of age, are the heaviest users of services (16). The Greater Vancouver Regional District population was therefore partitioned into four groups for purposes of this model: those under 65 years, 65-74 years, 75-84 years, and those over 85 years of age. These finer age groups were also used in the population projections to calculate estimated need/demand for services and to reflect more accurately future bed requirements.

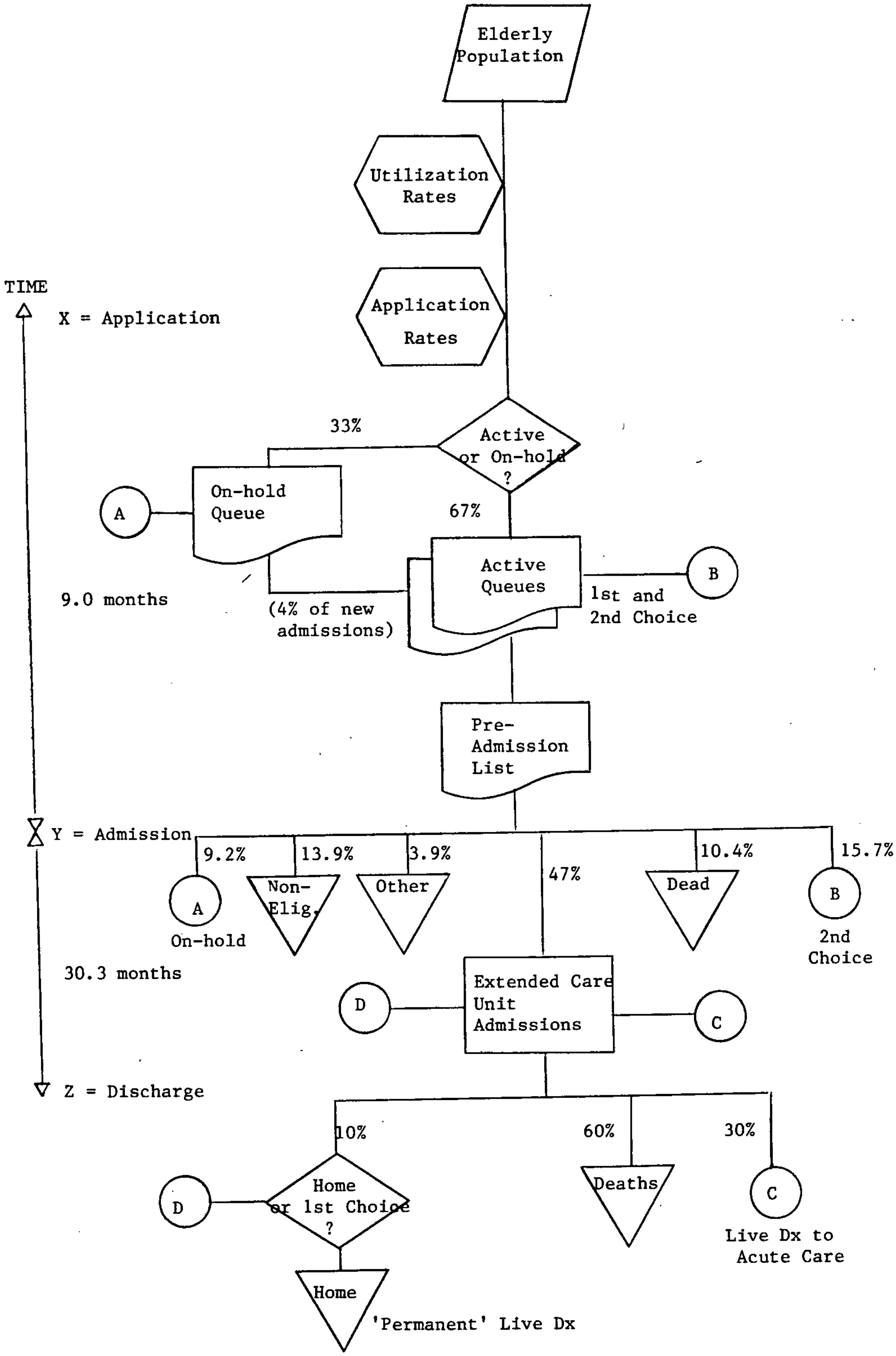

Figure 1. Flow Diagram of Movement of Extended Care Clients.

A recently developed population estimation and projection model (4) which takes very recent migration changes into account was used to project age-specific population increases for the municipalities of the Lower Mainland. The model is of the Cohort-Survival component variety, but is not sex specific.

Utilization rates: Morbidity rates are not available in British Columbia. Utilization data are very distorted substitutes for morbibity data, as long waiting lists exist for Extended Care beds. Utilization information from the census of Extended Care Units and Private Hospitals in the Lower Mainland provided proportions of clients in each age and sex group. Census information for Extended Care Units was collected by survey questionnaire, and for Private Hospitals from the Client Analysis Report of the Long Term Care Program.

Application rates: This flow variable is the main input to the model. This information is available by hospital, annually, but not by age and sex grouping. Age and sex specific application rates are estimated on the basis of the age and sex proportions from utilization census. These application rates were then projected to 1986 according to the estimated population increases for each age group (population projections were not available by sex). For all their limitations, the application rates are the best available estimates of demand on the system.

Active queue: At the time of application for Extended Care benefits the applicant may indicate if he wishes to be waitlisted on the 'active' or the 'on-hold' lists. In 1979, approximately one third chose the on-hold status and very few of these applicants later changed their waiting status to active in order to finally be admitted to an Extended Care Unit.

First choice: All active-list applicants give two choices of placement and are waitlisted simultaneously for both hospitals. The waitlists are strictly chronological, so that either a first choice or a second choice bed may be offered first, depending on which hospital has a vacancy. Waitlist data are not available in machine-readable form by age group and sex.

Pre-Admission List: When a hospital requests, Hospital Programs Division sends a pre-admission list containing the chronologically most senior names waitlisted for that hospital. The Pre-admission list is composed of both first choice and second choice lists. Data specific to age and sex were not available for this study. The inflow to the queue consists of all those applicants who chose to be waitlisted on the active list plus the small proportion of on-hold apaplicants who later 'activate' their status (approximately four percent of all new admissions).

The outflow from the queue consists of those applicants who are admitted plus those who 'drop out' for a variety of reasons.

A small percentage of applicants (3.7%) are rejected by the hospitals as unsuitable for admission because they may require continuous oxygen or have severe psychiatric symptoms, for example. These patients may either be admitted to another Extended Care Unit which can manage such patients, or they may be transferred to a more appropriate facility, such as an acute care hospital or a psychiatric unit. This group was of little consequence for the model and was therefore included with those applicants who had moved out of the region in the 'other' category.

Non-admitted patients: Of the applicants listed on the pre-admission list, 53% refuse the bed when it is offered. There are a number of reasons for this:

- dead: 10.4% have died during the waiting time. This proportion will increase with waiting time;

- non-eligible: 13.9% are no longer eligible for Extended Care benefits because their condition has improved. This proportion may also increase with the length of waiting time;

- on-hold: 9.2% choose to go to the on-hold waiting list at this point in time;

- second choice: 15.7% refuse the bed on the grounds that it was their second choice facility, and they prefer to wait for a bed in their first choice unit;

- other: 3.9% have either moved out of the area or have been rejected by the hospital as unsuitable residents.

All these data were collected by survey questionnaire from the Extended Care Units in the Lower Mainland.

Admissions: On the average, 47% of the patients listed on the Pre-admission list are eventually admitted to the Extended Care Unit (16). In this group are also included those applicants who are offered a bed in their second choice hospital and who accept this bed. These patients are admitted to their second choice hospital but may choose to transfer when a vacancy occurs in their first choice unit. New admissions account for 74% and re-admissions for 26% of all admissions for Extended Care Units.

The age and sex specific census for Extended Care Units and Private Hospitals as of September 1980 were applied to the population projection to estimate future application rates.

Length of stay statistics were collected from a sample of seven Extended Care Units (See Appendix C). Detailed information for patients discharged was gathered to obtain an estimate of the total length of stay as the sum of all admissions for each patient. Not included in this sum was the length of stay in another Extended Care Unit for patients who had transferred, but this portion was estimated according to the method outlined in data input.

Discharges: Sixty percent of discharges are at time of death. Only one fourth of the live discharges do not return to the same Extended Care Unit. They may go home, to another type of institution or to another Extended Care Unit (usually the first choice unit). Therefore, only 70% of all discharges will free up a bed in a particular facility.

The remaining 30% of discharges are to an Acute Care hospital. These patients will most likely return to the same Extended Care Unit and will therefore not free a bed. Extended Care Unit patients who are admitted to an Acute Care ward may fall into any one of three discharge disposition categories: deceased in Acute Care Unit, improved by treatment and discharged home; re-admitted to the same Extended Care Unit after they have recovered from the acute illness. If their length of stay in Acute Care was less than ten days, the Extended Care Unit bed will have been reserved and they are re-admitted promptly. If, on the other hand, the acute episode was longer than ten days, the patient will have lost the Extended Care Unit bed and will return to the top of the Pre-Admission List while waiting in the Acute Care ward. The detailed flow through Acute Care is not of consequence for the simulation model and has therefore been omitted.

A summary of the pertinent variables, their limitations for this simulation and suggested ideal data formats for future use are listed in Figure 2.

INPUT VARIABLE	LIMITATIONS OF DATA (in this simulation)	IDEAL DATA FORMATS
Initial beds	the number of existing beds is often greater than the number of rated beds and excludes S.T.A. beds.	existing beds = rated beds.
Initial queue	not available regularly, not by age group, sex or location.	monthly data, by age, sex and location.
Initial total wait	only annual data, very inaccurate, on-hold, transfers.	Current, by age, sex, and location, date of application.
Length of wait to date	not available.	distribution of current waiting time.
Occupancy rate	inaccurate - does not account for 48 hr lag time, nor 10 day absences.	include 10 day absence, 48 hour lag time.
Population Projection	only by school district, not by sex.	by municipality, by sex.
Census	utilization census rather than application census.	application and utilization census by age and sex
Applications	annual, aggregate, not accurate.	monthly data by age and sex
On-hold status	semi-annual, aggregate not accurate.	monthly, by age and sex and date of on-hold status
Pre-Admission List	not accurate, sporadic	continuously available
Length of stay	admission-separation data and not total length	total aggregate time for each case, transfer times
Inappropriate placements	not included in this model.	model based on application rate input

NOTE: The underlined variables are the most commonly used data for projecting future bed requirements in other studies reported.

Figure 2. Input Variables, Their Limitations and Suggested Ideal Format for Use in the Simulation Model.

2. Components

The FORTRAN simulation used in this study is a dynamic modeling of the inter-relationships of the variables for which data are available and accessible in the British Columbia Extended Care system. The model describes the flow of patients through the system, but does incorporate static variables as well when indicated.

The model is an iterative one, in which some of the output variables from one time run become the input variables for the next time period (queue length, number of beds, length of wait . The time-slice chosen in this model is one month; but most data were in annual format, so the model is rather a pseudo-monthly model (data were simply divided by 12). The basic blocks of the model are:

- Number of Extended Care Unit Beds
- Waiting Periods
- Application Rates
- Length of Stay
- Population Estimates

The model allows an estimation of changes in admission rates as the length of wait changes and therefore the proportion of patients who are admitted from the Pre-Admission List changes. On the other hand, the model does not allow for estimation of changes in the length of stay in an Extended Care Unit as a function of changes in waiting times and proportion of patients

Two possible situations are incorporated into the model: Case 1 - the time required to exhaust the queue is greater than the time-slice of the Simulation Model (in this case, one month), and Case 2 - the time required to exhaust the queue is less than the ti e-slice. Both situations can have either an increasing or a decreasing queue.

A) Input Data - data* included are:

Initial beds: The number of Extended Care Unit beds was 2466 for the G.V.R.D. in September 1980. The data were collected from the Extended Care Units by survey questionnaire to include only those beds which were used full-time, for regular admissions. An additional 40 beds came on-stream while this model was being developed to give a total number initially of 2506 Extended Care Unit beds in the district.

Added beds: The number of new beds added to the total complement varied with each experimental run as specified in (3) Options.

New active applicants*: The number of new applicants added to the active waiting list formed the input variable for a simulation. The number is based on two-thirds of all applicants being listed on the active list directly and is projected according to population increases for each age group. Initially, there were 139 per month, on the average, in 1979.

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* The indicated items (*) are data which it was necessary to compute or estimate.

Calculation of the number of new applicants per month was based on the percentage of utilization by each age group of Extended Care and Private Hospital beds. A coefficient was calculated from the 1979 application rate data (Hospital Programs Division) and this coefficient was multiplied by the projected population in each age group and summed to give a total application rate for each projected year.

'Activated' on-hold applicants: This small proportion (4% of all new admissions, N=3) was added to the above.

Inflow: The total inflow to the queue is therefore the sum of the new applicants and 'activated' on-hold applicants.

The inflow to the queue was calculated as:

INFLO = NEWAPP + HOLD

Where NEWAPP = new applicants per month

HOLD = applicants activated from on-hold waiting list

Waiting list: The average number of applicants initially on this list (N = 1186) was supplied by Hospital Programs Division.

Waiting time to date*: This time period was calculated from data collected by survey questionnaire regarding patients admitted to the units. This waiting time was arbitrarily set at half of total wait, and the value of the total wait was 9 months; therefore, wait-to-date was 4.5 months.

Expected Length of Stay*: The expected length of stay (ELOS) was estimated from data collected from the units.

It was estimated by adding weighted proportions of time for each number of visits according to the following formula.

$$ELOS = A + rB + r^2C + r^3D + T$$

Where: A = LOS for first visit

B = LOS for second visit

C = LOS for third visit

D = LOS for fourth and later visits

r = proportional coefficient (.3537)

r is the likelihood that a patient who has spent 'X' time during one visit will return for another visit. This coefficient was calculated to be .3537 for Extended Care visits ie., of the patients who had one visit, 36.8% returned for a second visit. Of these, 32.6% came for a third visit and 36.7% of the latter came for a fourth visit or more visit. The overall coefficient r was therefore estimated to be .3537.

And T = number of patients who transfer (5% of all new admissions) was calculated as:

$$LOS_T = \frac{LOS_{1st\ visit}}{2} \times .05$$

The overall ELOS was estimated to be 30.3 months (ie. $ELOS = 761.8 + .3537 \times 310.3 + (.3537)^2 \times 187.9 + (.3537)^3 \times 179.2 + (\frac{761.8}{2}) \times .05 = 922$ days

Discharges*: The number of 'permanent' discharges (Dx) per month was derived from occupancy rates, ELOS and the number of beds available in any given year, and was calculated to be 79.8 discharges per month.

The number of discharges per month was calculated as follows:

$$Dx = \frac{\text{average number of beds in the year} \times \text{occupancy rate}}{\frac{\text{ELOS}}{12}} / 12 = 79.8$$

New admissions: This number must be the same as the number of 'permanent' discharges per month from above as all beds are occupied; it was calculated in the same manner as the number of discharges.

Non-admitted applications*: The proportion of patients from the pre-admission list who are not admitted includes 10.4% who die and 13.9% who are ineligible (a further 9.2% go to the on-hold list and 3.9% are rejected, for a total of 37.4% - but the 15.7% who prefer their first choice hospital are not removed from the queue).

The proportion of adjusted admissions, the variable ZZ, which varies with the length of waiting time, was calculated as follows:

$$\frac{10.4\%}{9 \text{ months}} = .01155 \text{ die for every month of waiting}$$

$$\frac{13.9\%}{9 \text{ months}} = .01544 \text{ become eligible for every month of waiting}$$

so that the number of ineligible applicants multiplied by the total length of wait is ZZ = 2 Y (.01155 + . 01544).

The proportion of non-admitted applicants taken off the list each month in constant proportion is:

$$XX = \frac{(ZZ + .092 + .039)}{.47}$$

This is the total proportion of those who are taken off the list in constant proportions regardless of the length of wait, ie., 9.2% on-holds + 3.9% rejected.

Therefore, the total outflow from the queue becomes:

OTFLO = Admissions (1.0 + XX) (47% are admitted)

Calculations of rates of movements included the monthly flow of patients and average flow of patients through the queue:

$$MOFLO = INFLO - OTFLO$$

$$AVFLO = \frac{INFLO + OTFLO}{2}$$

Calculations of partial waiting times for the intermediate variables B, C, D, XAVG, G, F, and INITW are included under (B) Output Data below, in relation to the final output variables to better illustrate the rationale for each variable.

B. Output Data

'Final' number of beds: For each time run the number of initial beds for that run plus the number of beds added during the run of the model equals the number of current beds at the end of the run. This 'final' number of beds becomes the 'initial' number of beds for the next time period of the model. The same applies to the 'final' queue length for each time period:

$$FINQ = INITQ + MOFLO$$

Exhaust time (B) is the time required, B, to exhaust or deplete the total queue

$$B = \frac{INITQ}{OTFLO}$$

Two cases are possible; Case 1, when the time, B, required to exhaust the queue is greater than the time interval of the model and CASE 2, when the time required to deplete the queue is less than the time interval.

CASE 1: (B > 1) - Exhaust time (B) is greater than one month

Waiting time: The average waiting time for those who left the queue during the month is LEDFTW and is two times the average wait-to-date, Y.

$$LEFTW = 2\ Y$$

The average wait for new applicants entering the queue during the month (INFLO) is 0.5 months.

Intermediate variables: The average wait of the last applicant in the queue at the beginning of the month is F = 0 and at the end of the month F = F + 1.0. The average wait of the applicant at the top of the queue at the end of the month is G = 2Y, and the average wait of all applicants who are still in the queue at the end of the month is $XAVG = \frac{G + F}{2}$

Wait-to-date: The weighted average wait at the beginning of the next month for those applicants who are still in the queue is:

$$Y = \frac{XAVG\ (INITQ - OTFLO) + INFLO \times 0.5}{INITQ - OTFLO + INFLO}$$

CASE 2: (B < 1) - Exhaust time (B) is less than one month

Intermediate variables: The average total length of wait for those applicants who are already in the queue at the beginning of the month but who left the queue during the months is INITW = 2Y (or Y + Y, ie average wait-to-date at the beginning of the month, Y, plus average wait during the month, Y). The length of time, part of B, required to fill 1-B outflow is

$$C = \frac{OTFLO - INITQ}{INFLO}$$

The average wait in the queue for those applicants who entered the queue and left the queue during the same month is:

$$D = \frac{(1.0 - C + B)}{2}$$

Wait-to-date: The average length of wait in the queue for those applicants who entered the queue during the month and remained in the queue at the end of the month is:

$$Y = \frac{1.0 - C}{2}$$

Total wait: The average length of wait for those applicants who left the queue during the month is:

$$LEFTW = \frac{(D\ (1-B) \times OTFLO) + (INITW \times B \times OTFLO)}{OTFLO}$$

Table 1 lists the variables of the model and describes the sensitivity of the model to each of the variables.

An example, (C.) with hypothetical numbers is included to illustrate the steps in calculating the various waiting times and queue lengths.

TABLE 1.

SENSITIVITY OF MODEL TO VARIABLES OF INTEREST

Variable	Sensitivity*
Population projection	++
ELOS	+++
Beds	+
Application rate	+++
Queue Length	++
Waiting time	++
Holds	+++
Rejections	+
Occupancy rate	+

* + = low sensitivity
++ = medium sensitivity
+++ = high sensitivity

C. Example:

(the line numbers referred to are the line numbers of the computer program listing found in Appendix E)

Time-slice = 1 month - line 55

Number of initial beds = 2000 - line 8

Initial queue length = 1000 applicants - line 31

New applicants = 100 applicants per month - line 44

'Activated' from on-hold = 5 applicants per month - line 45

Expected length of stay in the Extended Care Unit = 20 months - line 62

Occupancy rate = 90 percent - line 63

Y (wait-to-date) = 5 months - line 31

2 Y (total wait) = 10 months - line 159

Added beds = 500 (in one month) - line 21

Discharges/month $= \frac{2500 \times .90/12}{20/12} = 112.5$ discharges per month - line 63

New admissions/month = 112.5 (must be the same as the discharges) - line 65

ZZ = 2 x 5 (.02255 + .01544) = .2699,

i.e., the proportion of applicants who are eligible - line 75

$$XX = \frac{(.2699 + .092 + .039)}{.47} = .853$$

i.e., the number of applicants taken from the pre-admission list - line 88

The outflow from the P.A.L., OTFLO, is then:

OTFLO = Admissions (1.0 + XX) = 112.5 (1.0 + .853) = 208.5

- line 89

The INFLO to the queue = 105

ie., new applicants + holds - line 92

MOFLO = 105 - 208.5 = -103.5

ie., inflow minus outflow - line 96

FINQ = INITQ + MOFLO = 1000 - 103.5 = 896.5

applicants at the end of the simulation - line 100

This example falls into the Case 1 group, as the time required to exhaust the queue is greater than one month.

ie., B > 1 or $B = \frac{1000}{208.5} = 4.80$ months - line 114

The average wait for those left the queue during the month is LEFTW = 10 months - line 121

$$AVFLO = \frac{105 + 208.5}{2} = 156.8$$

(ie., the average flow) - line 127

F = 1 month (ie., the wait of applicant who was last in queue at the start of the month now at the end of the month) - line 131

G = 10 months (ie., wait of applicant first in line at the end of the month) - line 134

$$XAVG = \frac{11}{2} = 5.5 \text{ months}$$

i.e., wait of all applicants left over - line 140

$$Y = \frac{(5.5\ (1000 - 208.5) + 105 \times .5)}{1000 - 208.5 + 105} = 4.9 \text{ months}$$

i.e., wait at the start of next month for those on the queue - line 142

Y (wait-to-date) = 4.9 months at the end of the first month. In the next simulation, LEFTW will be 9.8 months (2 x 4.9), i.e., the total length of wait before admission to the Extended Care Unit bed.

3. Options

A number of options or input assumptions are possible with the model. Different input scenarios will generate different outcomes in terms of queue length and waiting times. The following options were tested in this study:

A. the current application rate will remain constant (based on current proportional utilization and current demand).

B. a reduced application rate, eg., 10% lower rate. This situation might arise if all placements were to appropriate facilities and there were no delays in transfers.

C. a further reduction in the application rate eg., by 20%, might occur if alternative services were available and substituted an

D. increased application rate, eg., 10% increase, might occur if there were a change in behaviour of the elderly and their families so that demand for Extended Care Unit placement increased.

E. an increase in the number of 'activated' on-hold waitlisted applicants, might occur if the Private Hospitals gradually close down.

F. different time intervals for additions of beds (eg., all new beds would come on-stream at once, or x number of beds per year).

4. Technical Program Specificatin

The program was written in FORTRAN. It is 170 lines long. For a typical computer experiment costs are approximately as follows:

CPU time used	.473	$ .11
CPU stor VMI	.316 age-min	$ .01
Wait Stor VMI	.489 page-hr	$ .01
Lines printed	456.0	$ .09
Pages printed	9.0	$ .45
Approximate cost of this run is		$ .68

An example of a typical output of this model is enclosed in Appendix D.

CHAPTER IV

RESULTS

A series of computer simulations were conducted to describe the relationship between additional beds and reductions in waiting times, and queues. Several 'baseline' simulations were also run to verify the behaviour of the model.

The Greater Vancouver Regional Hospital District Board had already approved 200 additional Extended Care beds for the Region to be distributed as follows:

+ 40 beds at St. Michael's, May 1981

+ 54 beds at Surrey Memorial, September 1982

- 50 beds at Shaughnessy, January 1983

+ 125 beds at Lions Gate, September 1983

+ 31 beds at Peace Arch District, March 1984

These 200 additional beds are included in all simulations, except where indicated.

1. Baseline Simulations

A. The monthly application rate holds constant at 144.1 (1980 rate) and no new beds are added to the system. The waiting time remains almost constant at 9.2 months, but the length of the queue increases to 1364 (see table 2).

B. The monthly application rate remains constant at 144.1 but the 200 currently approved Extended Care beds are added. The waiting time is reduced to 7.4 months and the length of the queue to 1067 clients (Table 2).

C. The monthly application rate is projected to increase from 147.8 in 1981 to 163.6 in 1986. The projected application rate increase is calculated proportional to the projected population increase. When no additional beds are added, the waiting time increases to 11.2 months and the length of the queue grows to 1983 (Table 2).

D. The monthly application rate increases from 147.8 in 1981 to 163.6 in 1986 and the currently approved 200 new Extended Care beds are added. The length of wait increases only slightly to 9.6 months and the queue grows to 1643 (Table 2).

Table 2 shows that the 200 approved additional beds for the Region will not be sufficient to offset the increased need/demand resulting from projected increases in the elderly target population of 1986.

TABLE 2

WAITING TIMES AND QUEUE LENGTHS UNDER BASELINE SIMULATION CONDITIONS

Application Rate 1981	1986	Total Number of Beds	Waiting Time (months)	Queue Lengths (clients)
A 144.1*	same	2506	9.2	1,364
B 144.1	same	2706	7.4	1,067
C 147.8	163.6	2506	11.2	1,983
D 147.8	163.6	2707	9.6	1,642

* 1980 application rate (Clients per month)

2. The First Option

The increase in monthly application rates each year is proportional to the age-specific population increase.

Under this assumption, varying numbers of Extended Care beds are added to the system, from 100 beds to 1,900 beds. The new beds are added at three different time intervals: January 1984, January 1985, and January 1986, in approximately equal numbers. The resulting waiting periods and queue lengths are listed in Table 3. Included in the number of beds added to the system are the 200 currently approved Extended Care beds.

An additional 300 beds will maintain the status quo in terms of waiting periods, ie., 50 new beds per year will adequately offset the increased need generated by a growing elderly population. Reducing the waiting time to 6 months would require an additional 900 beds, with a resulting queue of 938 clients. It would be necessary to open at least 2,100 new Extended Care beds by 1986 to completely eliminate the waiting period.

TABLE 3

SIMULATED WAITING PERIODS AND QUEUE LENGTHS AT DIFFERENT BED LEVELS*

Number of Beds Added**	Total Number of Beds	Waiting Period (months)	Queue Length (clients)
300	2,806	9.1	1,540
500	3,006	8.2	1,321
700	3,206	7.2	1,124
900	3,406	6.3	938
1100	3,606	5.2	759
1300	3,806	4.2	594
1500	4,006	3.2	443
1700	4,206	2.2	302
1900	4,406	1.2	171
2100	4,606	0.4	49

* The application rates increased from 147.8 clients per month in 1981 to 163.6 in 1986.

** The 200 approved beds are included in the number of beds added.

The changes in waiting times as a function of additional Extended Care beds are described graphically in Figure 3. It can be seen that the model predicts approximately one year lag time between the addition of beds and the effect on the length of wait. Approximately three years lead time is required between the initial planning stage and the actual opening of new Extended Care beds. Therefore, approximately four years are required before the waiting time begins to show a reduction in length.

3. <u>The Second Option</u>

A reduced monthly application rate may be accomplished by ensuring that all placements are to appropriate facilities for Extended Care

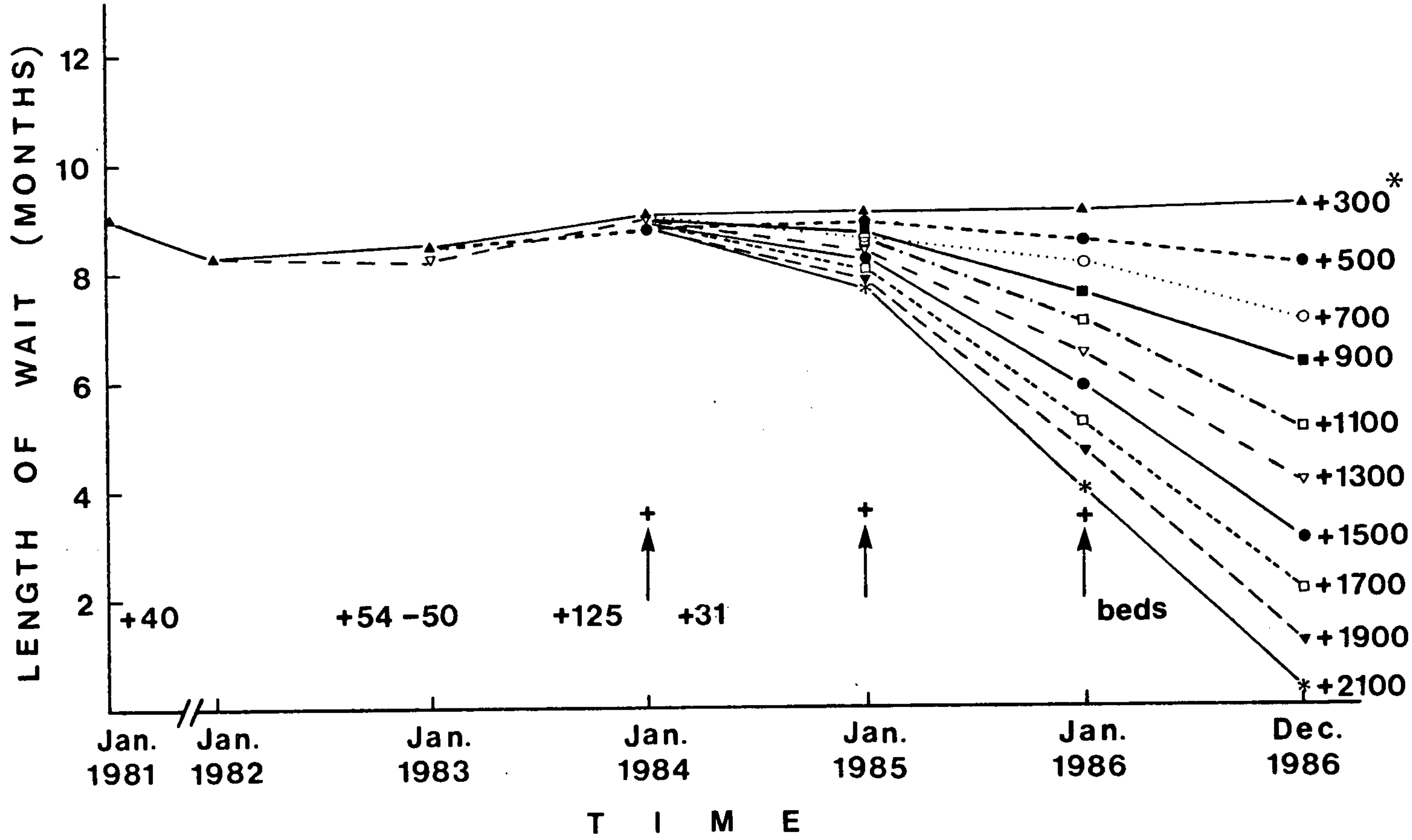

Figure 3. Length of Wait at Different Bed Levels (See Table 3).

Legend: ± beds indicate the time distribution of the 200 approved beds

+ ↑ indicates time distribution of simulated bed additions

* Total number of beds added

patients and that there are no delays in transfers of patients to other facilities when necessary. Such measures could possibly reduce the 'input' to the system by a maximum of 10%.

If alternative services were available as substitutes for Extended Care placements, the 'input' might register a maximum reduction of 20% (an arbitrarily chosen percentage).

The first part of Table 4 shows the effect on waiting periods and queue lengths when the input demand is reduced. A 10% reduction results in a waiting period of 6.3 months and a queue length of 953 clients. A 20% reduction results in a drastic decrease of both waiting time, to 3.5 months, and queue length, to 464 clients. Under both conditions, 300 new beds were added, which would otherwise have maintained status quo waiting period. The effect on waiting time is already evident after two years, as no "construction lag" is present in this option.

4. The Third Option

An increased application rate would be the result of a change in the demand behaviour of the target population and its families and care-givers. Increased expectations in the population as a result of well publicized services could potentially have this effect.

A 10% increase in the 'input' rate for Extended Care facility placements would result in longer waiting time, up to 11.7 months, and a longer queue of as many as 2,204 clients. Again, 300 beds were added to this simulation (Table 4`.

5. The Fourth Option

This simulates the effects of Private Hospital closures on the system. If all Private Hospital beds were to close over the next six years, the number of 'activated' on-hold waitlisted applicants would increase to 10 per month, plus one such applicant residing at home. Approximately 55% of all 1,300 Private Hospital beds are occupied by Extended Care eligible clients. Table 4 shows that there would be a longer wait, 10.5 months, and longer queue, 1,861 clients, as a result. As in previous options, 300 beds were added in this situation.

TABLE 4

SIMULATED WAITING PERIODS AND QUEUE LENGTHS AT DIFFERENT APPLICATION RATES

Demand Level	Application Rate 1981	1986	Final Waiting Period (months)	Final Queue Length (clients)
-10%	133.0	147.2	6.3	953
-20%	118.2	130.9	3.5	464
+10%	162.6	180.0	11.7	2,204
+11% on-holds	158.8*	174.6	10.5	1,861

*Includes those activated from the on-hold waiting list.

The effect of changing the 'input' rate in Options 3, 4, and 5 above on the length of the waiting period is shown graphically in Figure 4.

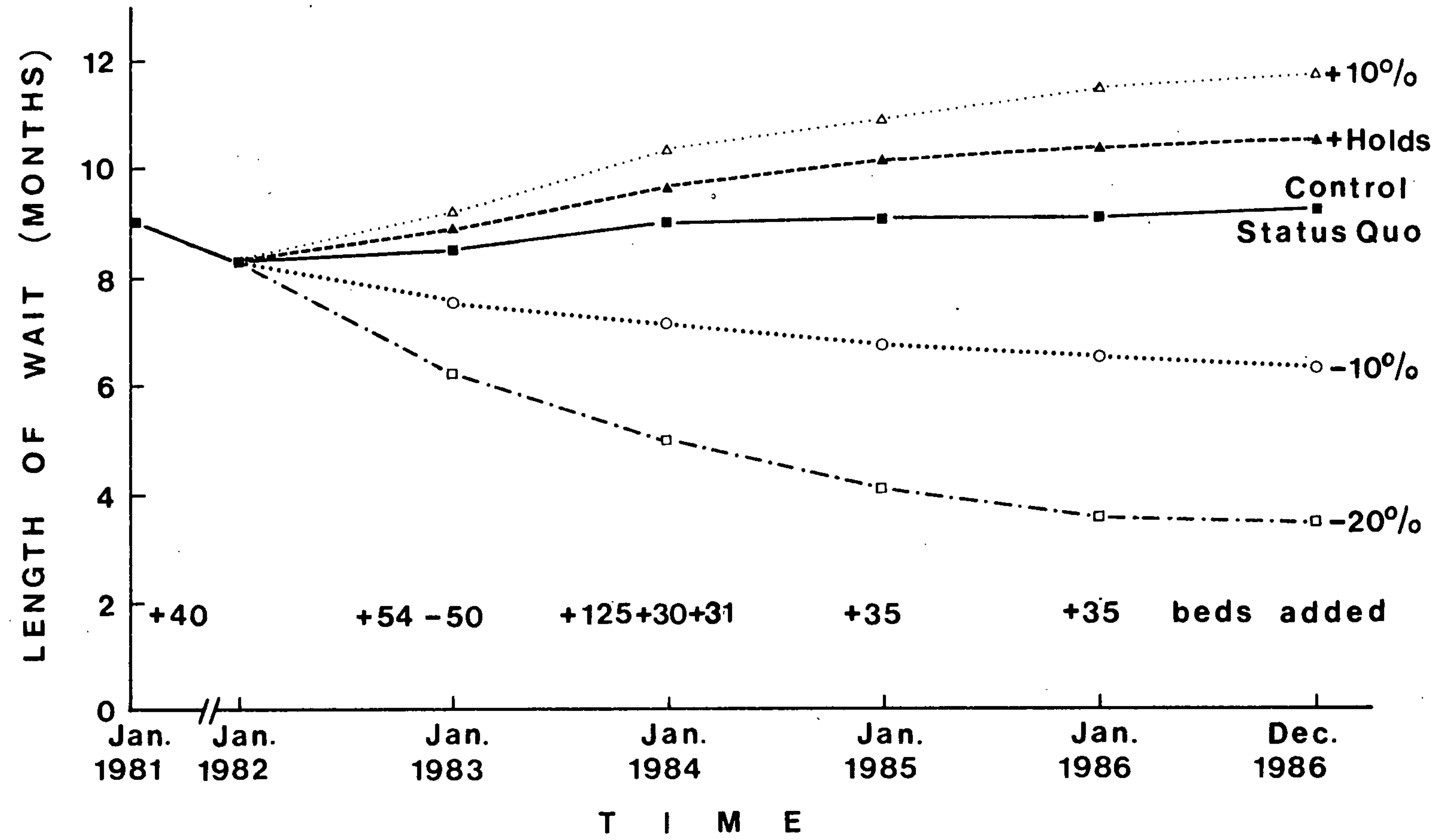

Figure 4. Length of Wait at Different Application Rates and Total Bed Additions Fixed over Time (see Table 4)

Legend: ± beds indicate the time distribution of additonal beds
- ·····△ indicates a 10% increase in application rate
- ----▲ indicates an increase in activated on-hold applications
- ——■ indicates control (status quo) condition
- ·····○ indicates a 10% reduction in application rate
- —·—·□ indicates a 20% reduction in application rate

6. Different Intervals

Finally, the response of the model to a different 'pulse' of additional beds is included in Table 5. All new beds are added at one point in time and the effect is noticeable after a shorter lead time. Three simulations were conducted: 100 new beds, 900 new beds, 1,900 new beds. During all three runs, the fixed 200 approved beds were also included.

Table 5 shows that 100 beds added at once (in January 1984) would result in a slightly shorter waiting time, 8.8 months, and a queue length of 1,496 clients. An addition of 900 beds in January 1984 would result in a very much shorter waiting period, only 3.4 months, and a queue length of 546 clients. The addition of 1,900 beds in January 1984 reduced the waiting time to zero in November 1985 and depleted the entire queue at the same time (Figure 4).

Table 5 describes the fluctuations in waiting times for all simulation options described above.

TABLE 5

EFFECT ON WAITING PERIODS AND QUEUE LENGTHS

AT THREE SIMULATED BED ADDITIONS IN JANUARY 1984

Simulation	Additional Beds Added* (January 1984)	Total Number of Beds*	Waiting Period	Queue Length
1	100	2,806	8.8	1,496
2	900	3,606	3.4	546
3	1,900	4,606	0.0**	0**

* The approved 200 beds are included, as scheduled
** The waiting time and the queue both reached 0 in November 1985

TABLE 6

DETAILED WAITING PERIODS (MONTHS) FOR SIMULATION EXPERIMENTS

WHEN BEDS ARE ADDED IN THREE INTERVALS,

JANUARY 1984, JANUARY 1985, AND JANUARY 1986

Date	Number of Beds Added January 1984, January 1985 January 1986*									
	(100)	(300)	(500)	(700)	(900)	(1100)	(1300)	(1500)	(1700)	(1900)
	WAIT IN MONTHS									
January 81	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
January 82	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3
January 83	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5
January 84	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
January 85	9.1	8.9	8.6	8.7	8.6	8.4	8.3	8.1	7.9	7.8
January 86	9.1	8.6	8.2	7.7	7.1	6.5	5.9	5.3	4.7	4.0
December 86	9.1	8.2	7.2	6.3	5.2	4.2	3.2	2.2	1.2	0.4

*Beds added in approximately equal proportions in all intervals, e.g. 100 beds added as 35 in January 1984, 35 in January 1985 and 30 in January 1986.

TABLE 7

DETAILED WAITING PERIODS (MONTHS) FOR SIMULATION EXPERIMENTS

WHEN BEDS ARE ADDED IN ONE PULSE IN

JANUARY 1984

Date	Number of Beds Added January 1984 (100)	(900)	(1900)
	WAIT IN MONTHS		
January, 1981	9.0	9.0	9.0
January, 1982	8.3	8.3	8.3
January, 1983	8.5	8.5	8.5
January, 1984	8.9	8.9	8.9
January, 1985	8.9	7.0	3.2
January, 1986	8.8	4.4	0.0
December, 1986	8.8	3.4	0.0

TABLE 8

DETAILED WAITING PERIODS (MONTHS) FOR SIMULATION EXPERIMENTS

UNDER DIFFERENT QUEUE CONDITIONS

Date	Altered 'Input' Rates			
	-10%	-20%	+10%	+11 Holds
	WAIT IN MONTHS			
January, 1981	9.0	9.0	9.0	9.0
January, 1982	8.3	8.3	8.3	8.3
January, 1983	7.6	6.2	9.2	8.9
January, 1984	7.2	5.0	10.3	9.7
January, 1985	6.8	4.1	11.0	10.2
January, 1986	6.5	3.6	11.5	10.4
December, 1986	6.3	3.5	11.7	10.5

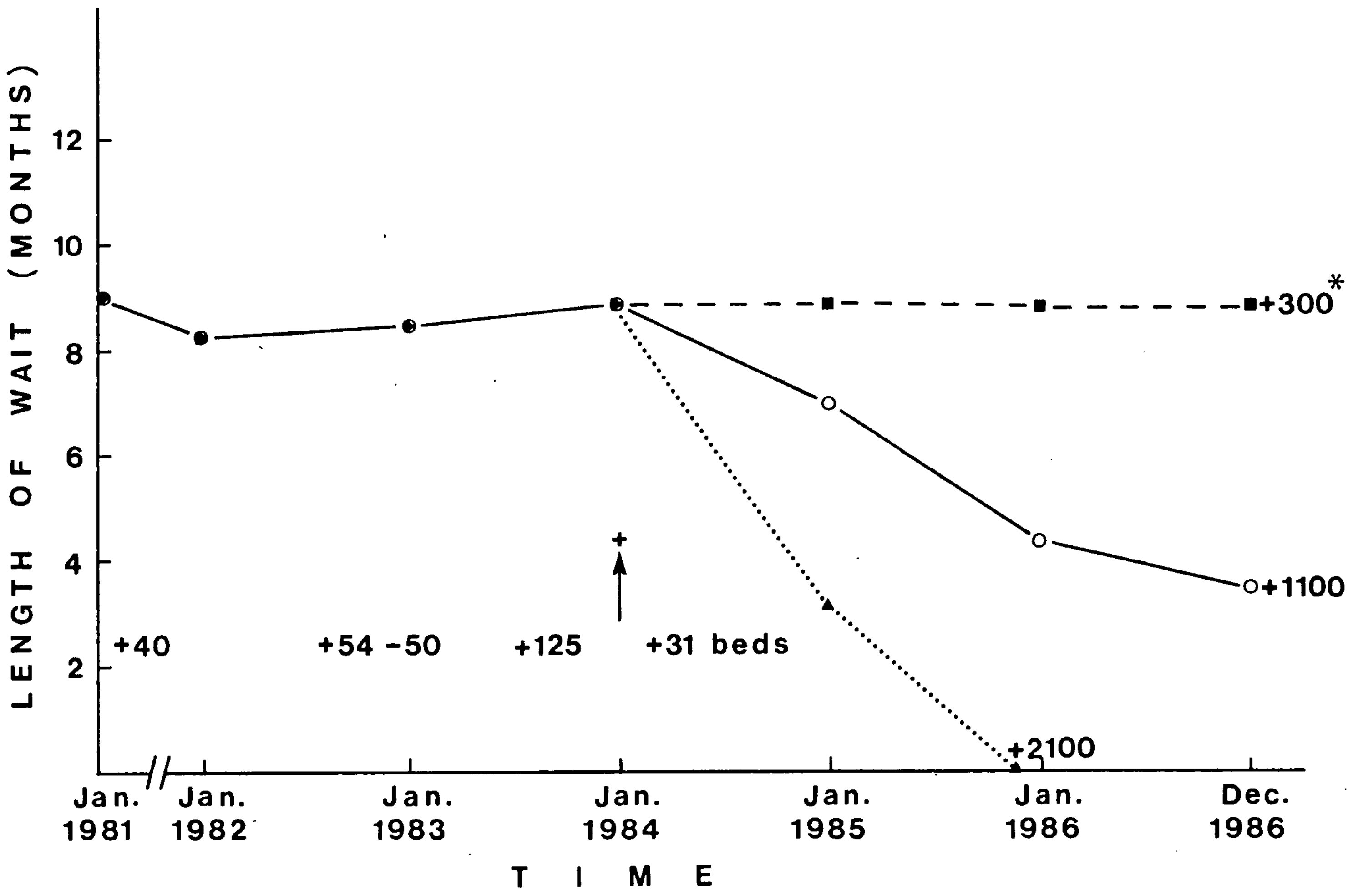

Figure 5. Length of Wait at Different Pulse Rates (see Table 5)

Legend: ± beds indicate the time distribution of the 200 approved beds

↑ indicates the single pulse of simulated bed additions

* Total number of beds added

CHAPTER V

DISCUSSION

An attempt was made to compare a number of different planning methodologies for forecasting institutional service requirements, specifically Extended Care beds, for the elderly population within the Vancouver region. Planning techniques are highly dependent on the accuracy and the availability of data for projections of the effect of options and their likely outcomes.

The critical assumptions of the study model, including time frame, length of wait, length of stay, and behavioral aspects of demand generation, are discussed below, followed by a discussion of alternative planning methodologies. The applicability of the study model to long term care is then discussed.

The simulation modelling technique provides an important basis for policy formulation and analysis in the area of health services for the elderly. Future research areas and policy implications are also discussed.

1. Critical assumptions of the study model

A. Time frame

The majority of data items collected were in the annual or semi-annual format. This is often the case in health care institutions, as statistical activities are concentrated around budget needs each year in order to be minimally disruptive to the regular patient care routine.

A simulation model, however, performs more accurately the narrower the time interval between each iteration.

Any simulation model requires several iterations to reach equilibrium, and for this short-term forecasting model (six years) that is not acceptable. A weekly model would, of course, reach this equilibrium even faster, but a weekly time interval would be totally unrealistic from a data collection point of view. Monthly and weekly models were tested - the data were simply divided by the appropriate number of months or weeks.

B. Length of Wait

The mean length of wait was chosen as the input to the simulation. It is possible that the mode (most frequesntly occurring) length of wait might have been a more accurate measure of this variable. However, the mean lends itself to mathematical manipulations more readily.

It would also have been more mathematically correct to use a distribution of length of wait to date, and of length of stay as well, rather than the mean of the total length of wait. It was, however, not possible to obtain the wait-data in this format.

C. Length of Stay

The simulation modeling technique used in the present study assumed that the expected length of stay in an Extended Care Unit would remain constant over the forecast period (1981-1986) regardless of any changes in inputs.

This may not be the case, as a number of factors may influence and change the expected length of stay, some of which are discussed below.

If the length of wait changes the proportions of deceased and/or improved on the pre-admission list at the time a vacancy occurs will have changed. This may affect the mix of patients who are admitted and subsequently their length of stay. Changes in morbidity patterns among the elderly will have significant effects on the Expected Length of Stay as will new treatment techniques.

Priorization of admissions would also change the patient mix of those admitted to an Extended Care Unit. If patients waiting in an acute care bed for admission to an Extended Care Unit are given priority, it is possible that patients may be less deteriorated when admitted to the Extended Care Unit and this may affect the expected length of stay.

If there is a change in the proportions of patients who transfer from their second choice Extended Care Unit to their first choice Unit when a vacancy occurs, it is also likely that the overall expected length of stay of the units will be altered.

D. Behavioral Aspects of Demand Generation

The present forecasting model is based on an assumption that some of the input variables remain constant over the forecasted time period, ie., application rates, expected length of stay and age distribution of applicants remain constant. This assumption may not hold, for a variety of reasons.

Increased supply of services often induces, or generates, additional demand, since the awareness of services increases among the elderly and their care-giving families. The simulation model can estimate the amount of generated demand after several iterations, so long as all input variables are updated each year (or month, if possible).

Therefore, if the application rate increases more than would be expected on the basis of population increases, this additional demand would be attributed to 'generated' demand. This portion of generated demand may not be the entire generated demand, as the initial application rate used in the model was an expression of utilization rates and not true morbidity rates, and therefore had initially a 'generated demand' component built in.

However, this latter 'generated demand' portion may be a legitimate expression of need as the elderly population may be aging faster than projected and the phenomenon of the 'thinning' of the family further reduces the informal home support for the elderly person. In order for formal home support systems to be effective, informal support, most often provided by spouses and daughters, is a necessary supplement (81). But as the spouses and even the daughters themselves age, the informal support systems are becoming less evident. This may, in turn, contribute to a higher demand as evidenced by an increase in the application rate for admission to Extended Care Units.

Changes in expected length of stay, as a result of new treatment techniques, will also affect length of wait and length of the queue.

E. Equity of Extended Care Services

If equity of service in different municipalities within a region is a planning goal, the municipal bed to population ratio should all be identical, if such ratios are based on the differential utilization projected for each 10-year age group. It is a simple matter to calculate the required bed ratio for any given length of wait and then determine the additional number of beds required.

This would not apply for a municipality which would provide a regional, specialized service, eg., Assessment and Treatment Centre services. These would be projected separately on a regional need basis.

2. Alternative Planning Methodologies

The purpose of developing the current simulation technique for planning bed requirements was to develop a planning method which would more accurately project these requirements by taking more variables into account and including the dynamic nature of the problem. For comparative purposes, the Greater Vancouver Regional Hospital District data has been applied to the four other, linear, projection methodologies described in Chapter II.

A. British Columbia Hospital Programs Division Method

The projection method outlined on page 35, when applied to the data collected for this study, resulted in 1,057 additional beds being required by 1986 which would yield a bed to population ratio of 23.6 Extended Care Unit beds per 1,000 population 65 years of age and over. The length of wait, according to the simulation model, would be 5.4 months in 1986 and the total number of beds 3,565 in that year.

B. British Columbia Long Term Care Bed Allocation Formula

The method suggested by the Long Term Care Program is based on the utilization of institutional services by the elderly in two Health Units, one urban and one semi-rural, during 1978, described on page 33. Application of this formula to the data at hand for this study would result in the recommendation of 1,788 additional Extended Care Unit beds for a bed to population ratio of 28.9 per 1,000 65+ and an estimated waiting time of two months.

However, this includes Private Hospital beds currently occupied by Extended Care eligible clients. If such beds are not included in the analysis, an additional 1,084 Extended Care Unit beds would be required with a resulting waiting period of 5.5 months at the same (28.9) total bed ratio per 1000 population over 65 years.

C. Ottawa-Carleton Bed Projection Formula

Use of the method employed to forecast bed requirements in the Ottawa-Carleton study, referred to on page 20, resulted in a recommended total of 2,881 beds, or 375 additional beds. The length of wait in this projection would be 8.8 months, and the bed to population ratio 19.1 per 1,000 over 65 years of age. This method does not take into account the Private Hospital beds occupied by Extended Care eligible clients. If those beds were added to this projection, the resulting total number of beds required would be 3,690 of which 1,184 would be new Extended Care Unit beds. The length of wait would become five months and the bed to population ratio 24.4 per 1,000 65+.

D. Metro-Toronto Formula

The method employed by planners in the Metro-Toronto region would result in a total bed requirement of 4,102 Extended Care Unit beds for the Vancouver region, or 1,596 additional beds, with a resulting waiting period of 2.7 months and a bed ratio of 27.3 per 1,000 population over 65. The methodology is described on page 29.

E. Study Simulation Model

In order to maintain a constant waiting period of 9 months, an additional 300 Extended Care beds were estimated to be required by 1986. The length of the waiting list, or the queue, would increase slightly under such conditions. An additional 2,200 beds would be required to eliminate the waiting period completely and to deplete the queue.

F. Summary

It is apparent that these different planning methodologies result in very different bed estimates. These data are shown in Table 9. With the exception of the simulation mode, all methods are linear extrapolation techniques. As the dynamic nature of the variables is not taken into account, it is not surprising that each method gives very different waiting time results.

All four methods project the bed requirements on the basis of the over 65 years of age population, without giving any consideration to the differential utilization by the young-old (65-74), the medium-old (75-84), and the old-old (85+).

The simulation technique used in this study does allow for separate projections for each finer age group in the elderly population, acknowledging that different fractions of the elderly make different contributions to the overall projected Extended Care utilization rates.

TABLE 9

COMPARISON OF PROJECTED EFFECTS OF OPTIONS AND OUTCOMES USING DIFFERENT PLANNING METHODS

Planning Methods	Additional Beds	Total Number of Beds	Lenth of Wait (Months)	Bed/Population Ratio per 1000 65+
B.C. Hospital Programs Divison	1,057	3,565	5.4	23.6
Long Term Care Bed Allocation	1,788	4,294	2.0	28.9
Ottawa-Carleton	375	2,881	8.8	19.1
Metro-Canada	1,596	4,102	2.7	27.3
Study Model	300	2,806	9.1*	18.6
Study Model	1,500	4,206	2.2**	37.9

*Status quo waiting time
**Waiting time set at 2.2 months

3. Applicability of model to Long Term Care

A. Long-Term Care Services

The simulation modelling technique for planning future bed requirements could very easily be adapted to include all of the Long Term Care program.

The modifications which would be required to adapt the model to Long Term Care use include allowing three choices of facility placement, and a priority or emergency admission procedure for by-passing the chronological waiting list.

The Long Term Care system is a more complex system, providing both institutional care and home-based health services. The model could be adapted to include a home support component as well.

The model could be employed to project the 'care-careers' of clients through the system. The proportions of those who deteriorate from level to level in a Markovian fashion versus those who become Extended Care eligible directly could be estimated and analyzed.

B. Alternative Services

The present simulation technique only incorporates variables related to institutional service provision, but it would be possible, as mentioned, to add a home service component. This additional alternative service would be assumed to reduce the level of expressed demand for facility placement as indicated in Table 4 and Figure 4. This assumption is not based on any definitive evidence and would depend on how the recipients of home support services are chosen (82).

4. Conclusion and Recommendations

A. Study Findings

The study model predicted that in order to maintain current waiting periods for admission to Extended Care Units an additional 300 beds would be required by 1986. The waiting period as well as the queue vary with number of additional Extended Care beds added to the system so that 2,200 new beds were added the queue would be depleted entirely and the waiting period eliminated. These results would assume that all other factors remain constant.

B. Effect of Priorization of Applicants

As the health care sector assumes new levels of complexity, the tasks of identifying, evaluating and choosing among many available options become increasingly difficult for the policy maker. Objective planning techniques based on quantitative analysis are emerging as both relevant and practical tools in the field of health services planning.

The simulation model developed in this study, albeit deficient in some areas, describes the logical relationships among the variables which must be included in the forecasting equation for projecting Extended Care beds. It is, however, important to keep the limitations of such a model in mind when making policy and planning decisions.

The model is a very simple description of the Extended Care system and does not allow estimation of waiting periods or queue lengths should certain 'ground rules' of the system change. One such change could possibly be the instituting of a priority-admission system based on assessed need rather than eligibility based on assessed functional levels and chronological wait lists.

If a need-priority system were implemented for admissions to an Extended Care Unit, it is quite possible that utilization patterns, and therefore the input (application rate) to the system, would change with corresponding changes in outcome measures as the entire flow of patients through the system would be different.

A priority-based admission system can be based not only on a need parameter, but also on other characteristics, for example present residence of applicant. It is possible that patients awaiting admission to an Extended Care Unit in an Acute Care hospital may be given a higher order of priority, and this may, in turn, affect the patients waiting in the community, so that the medical characteristics of admitted patients would be altered.

C. Research possibilities

The area of data requirements for quantitative analysis in chronic care planning needs to be investigated further. It may not be possible, from a practical point of view, to collect data monthly.

Information as to age, sex, and residency of the applicants on the waiting list is crucial to more accurate predictions resulting from the model.

Research into the degree of 'generated' demand is also of prime importance. Is this demand frivolous or is it the result of diminishing family support, or the acceleration of the aging phenomenon?

The effect on expected length of stay as a result of many possible changes in a variety of variables also needs to be investigated. Will priorization of applicants, changes in the medical mix of patients and advances in treatment technologies result in longer stays in the Extended Care Units?

Finally, an area of future research which has very important policy implications is the gain in life expectancy and in years free of institutionalization as a result of preventive service provisions.

D. Policy implications

When the nature of observed additional demand, the so-called 'generated' demand, is determined policy decisions will be required. As well, a true increase in the morbidity among the elderly and a diminishing of available informal support systems may require increased service provision by the public sector in the form of increased institutional supply. An increase in pure demand, however, may on the other hand require a policy action directed to discouraging applications for facility placement and providing alternative services instead. (Day Hospitals, Home Support Services, Volunteer Systems etc.)

Increased expected length of stay as a result of improved treatment regimens may also require policies which address the question of the rationale for treatment interventions in general. To what degree should active treatment persist?

Finally, priorization of applicants may have implications for Acute Care facilities which will demand policy changes in that area as well.

The present study is an attempt at developing technique for projecting future Extended Care bed requirements. The study model incorporates dynamic variables which would enable the planner to assess and to adjust projections continuously. It would also enable the policy maker to attain a better understanding of the various factors which together exert pressure on facility beds, both Acute Care and Extended Care, in the system.

TABLE 8

DETAILED WAITING PERIODS (MONTHS) FOR SIMULATION EXPERIMENTS UNDER DIFFERENT QUEUE CONDITIONS

Date	Number of Beds Added January 1984 (Wait in Months)			
January, 1981	9.0	9.0	9.0	9.0
January, 1982	8.3	8.3	8.3	8.3
January, 1983	7.6	6.2	9.2	8.9
January, 1984	7.2	5.0	10.3	9.7
January, 1985	6.8	4.1	11.0	10.2
January, 1986	6.5	3.6	11.5	10.4
December, 1986	6.3	3.5	11.7	10.5

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APPENDIX A

Eligibility criteria for different levels of long term care.

Eligibility Criteria for Personal Care

A. Characteristics of Personal Care

1. Personal Care Provides:

a. 24 hours a day supervision by non-professional (lay) personnel;
b. a protective support environment;
c. assistance with the activities of daily living;
d. a planned program of social recreational activities.

2. The applicant at this level of care will require minimum of 30 minutes of available individual attention by non-professional (lay) personnel during each 24 hour period.

B. Criteria

1. The following criteria shall be used to determine the eligibility of an applicant for Personal Care.

a. Communication - the applicant
(1) will be able to express needs; but may communicate with difficulty because of special disabilities or medical problems; and
(2) may or may not have serious vision or hearing disabilities.

b. Personal Functions - the applicant

(1) will be independently mobile with or without mechanical aids;
(2) will be able to transfer* without human surveillance;
(3) may require minor help to bathe, dress and attend to grooming; (for example, assistance in getting in or out of the bathtub, shower, or help with hair washing, cutting nails, help with zippers, buttons, shoelaces)
(4) will be able to toilet self with or without reminders;
(5) may have rare incontinence;
(6) will be able to feed self but may need assisted meal service, such as table setting for a blind person, cutting of food for arthritic persons;
(7) may require special access to toilet/bathroom because of continued use of wheelchair.

B. 1. c. Mental Functions - the applicant

(1) may have full use of mental functions
(2) may demonstrate forgetfulness, mild confusion and/or behaviour patterns that mildly disturb others (rarely wanders, has mild depression, slightly withdrawn);
(3) may have mild impaired comprehension.

d. Medical Problems - the applicant

(1) may have medical conditions that are stabilized and do not require daily professional supervision;
(2) may require supervision to ensure that health care appointments are made and kept;
(3) may require special diets of a simple nature (simple diabetic, low salt, low calorie, low residue and sugar free, etc.)

e. Social Functions - the applicant

(1) may require assistance to maintain independence in some activities of daily living.

<u>ELIGIBILITY CRITERIA FOR INTERMEDIATE CARE I</u>

A. Characteristics of Intermediate Care I

1. Intermediate Care Level I provides:

a. 24 hours a day supervision by non professional (lay) personnel;
b. daily supervision by health professional staff;

* Transfer means to move from article of furniture or equipment to another. For example, from bed to chair, from one chair to another, from wheelchair to toilet and return.

c. necessary assistance with the activities of daily living such as dressing, washing, grooming and bathing;
d. a protective and supportive environment;
e. a planned program of social and recreational activities.

2. The applicant at this level of care will require minimum of 75 minutes of available individual attention during each 24 hour period as follows:

   a. Professional - 15 minutes/day
   b. Non-professional - 60 minutes/day

B. Criteria

1. The following criteria shall be used to determine the eligibility of an applicant for Intermediate Care I:

   a. Communication - the applicant

      (1) may have difficulty expressing needs (eg. dysphasia);
      (2) may be unable to adapt to sensory loss.

   b. Personal Functions - the applicant

      (1) will be independently mobile with or without mechanical aids;
      (2) may need specialized aids for independently transferring*;
      (3) may need moderate amount of assistance with bathing, dressing and grooming;
      (4) may require reminder or routine toilet to avoid frequent incontinence;
      (5) may require assistance with toileting to maintain cleanliness;
      (6) may need some supervision in eating;
      (7) may need directional assistance;
      (8) may need occasional enemas.

   c. Mental Functions- the applicant

      (1) may be mildly depressed or agitated;
      (2) may have moderately impaired comprehension (has the ability to understand simple instructions, simple number and time concepts);
      (3) may be unable to express some needs;

* Transfer means to move from article of furniture or equipment to another. For example, from bed to chair, from one chair to another, from wheelchair to toilet and return.

(4) may demonstrate difficulty in orientation as to day, time, place;
(5) may have varying degrees of mental defects and deterioration.

d. Medical Problems - the applicant

(1) will require daily supervision by professional health staff;
(2) may require nursing procedures such as:
i. supervision of medications;
ii. change of surgical dressing;
iii. supervision of catheter and ostomy apparatus.
(3) may require supervision for visits to doctor, dentist, eye specialist, etcetera;
(4) may require therapeutic dietary supports (diabetic and other special therapeutic diets);
(5) will require regular review by a physcian;
(6) may require specialist services from time to time (physiotherapist, occupational therapist, speech therapist);
(7) may require therapeutic services for a psychiatric problem.

e. Social Functions - the applicant

(1) will require a protective atmosphere;
(2) will require a program of activities to maximize potential;
(3) will require programs for social and recreational activities;
(4) may be attending a workshop, educational course or equivalent.

ELIGIBILITY CRITERIA FOR INTERMEDIATE CARE II

A. Characteristics of Intermediate Care II

1. The basic characteristics of this level of care are the same as for Intermediate Care I.

2. This level of care recognizes a heavier level of care and/or supervision requiring additional care items.

3. The applicant at this level of care will require approximately 100 minutes of available individual attention in each 24 hour period as follows:
    a. Professional - 30 minutes
    b. Non-professional - 70 minutes

B. Criteria

1. The criteria for Intermediate Care II are as for Intermediate Care I. However, the applicant for this level of care

    a. may need considerable directional assistance, supervision of activities, etcetera;
    b. may present management problems due to wandering;
    c. will present staff difficulties or require extra staff time due to impaired comprehension;
    d. may occasionally misappropriate the property of others;
    e. may have multiple disabilities/medical problems;
    f. may have need of more variety and/or extensive professional services;
    g. may be incontinent of bladder and/or bowel;
    h. may have severe disability/medical problem;
    i. may have an indwelling catheter;
    j. may need assistance with eating;
    k. may require daily professional supervision of catheters, surgical dressings, colostomy, oxygen therapy, etcetera.

<u>ELIGIBILITY CRITERIA FOR INTERMEDIATE CARE III</u>

A. Characteristics of Intermediate Care III

1. The basic characteristics of this level of care are the same as for Intermediate Care II.

2. This level of care essentially recognizes the psychogeriatric person who has severe behavioural problems on a continuing basis. However, this level of care may also be used for:

    a. persons requiring a heavier level of care involving considerably more staff time than at the Intermediate Care II level but who are not eligible for Extended Care; and
    b. persons who are eligible for Extended Care and are awaiting transfer to an extended care unit.

3. The applicant at this level of care will require at least 120 minutes of individual attention during each 24 hour period as follows:

    a. Professional - 30 minutes
    b. Non-professional - 90 minutes

B. Criteria

1. The criteria for Intermediate Care III are as for Intermediate Care II plus the following:

   a. the applicant may disturb others with such anti-social habits as spitting, voiding and defecating in public, and indecent exposure, etcetera;
   b. this person may exhibit destructive, aggressive or violent behaviour (shouting or screaming);
   c. this person may continually wander away; or
   d. this person may endanger own life.

ELIGIBILITY CRITERIA FOR EXTENDED CARE

A. Characteristics of Extended Care

1. An Extended Care Unit or Hospital provides for:

   a. around-the-clock supervision by a graduate nurse as well as;
   b. supervision by various other professional health workers such as;
      Pharmacist, Dietitian, Occupational/Physiotherapist, and Social Worker
   c. regular medical supervision;
   d. simple nursing procedures once a day or more often, such as application of surgical dressing, administration of injectable medications, oxygen therapy (low concentration, low flow) or catheter care;
   e. fulfillment of social needs of the beneficiary;
   f. a home-like environment;
   g. a program to assist each beneficiary to retain or improve his functional ability;
   h. skilled assistance with activities of daily living, such as dressing, washing, grooming and bathing.

2. In Extended Care, the length of time required by the applicant for skilled and professional health staff services may vary widely but will average over 150 minutes. Professional to non-professional ratio of staff approximately 1:4.

B. Criteria

1. The following criteria shall be used to determine the eligibility of an applicant for extended care;
   The applicant -

   a. will not at the time require the services of an acute, rehabilitation or psychiatric hospital;

b. will, in order to be mobile, require human assistance and sometimes also the use of mechanical aids such as braces, walkers, grab bars, canes and crutches (but not articles of furniture) in order to:

   i. turn and move about in bed;
   ii. transfer* and walk with safety a distance of at least 15 feet clear space; or
   iii. transfer* and operate a wheelchair safely, including use of footpedals and brakes.

c. may be mobile without human assistance but will require, for medical reasons, 24 hour-a-day surveillance by professional health care staff;

d. may be mobile without human assistance but will regularly require the performance of one or more simple specific nursing procedures more often than once daily - for example, giving of injectable medications, the change of surgical dressings, the treatment of pressure sores, the delivery of low-concentration, low-flow oxygen, catheter and ostomy care; or tube-feeding (except when there is also a tracheostomy).

2. In addition to the above criteria for eligibility, applicants may demonstrate the following:

   a. Communication - the applicant
      (1) may have difficulty expressing needs or be unable to express needs.
      (2) may be unable to adapt to visual or auditory losses, for example, a blind person who is also confused.

   b. Personal Functions - the applicant
      (1) may require a varying amount of assistance with dressing, washing, grooming and bathing.

   c. Mental Functions - the applicant
      (1) may or may not be mildly depressed or agitated;
      (2) may or may not have moderately impaired comprehension (ability to understand only simple instructions, short retention span);

   d. Medical Problems - in addition to those problems related to eligibility

* Transfer means to move from one article of furniture or equipment to another; for example from bed to chair, from one chair to another or from wheelchair to toilet etcetera (additional note - the individual who can transfer without human assistance, but needs assistance to walk or use a wheelchair and the individual who can walk or use a wheelchair without human assistance but needs assistance to transfer, are both considered eligible for Extended Care).

the applicant

(1) will require monthly or more frequent visits by a physician;
(2) may require a therapeutic diet;
(3) may require brief periods of individual Physio-or Occupational Therapy;
(4) may require professional monitoring and judgement on a continuing basis for a psychiatric problem (may not be available in all Extended Care Units);
(5) may be mobile without human assistance but exhibits gross fecal or urinary incontinence;
(6) may be mobile without human assistance but will require, for medical reasons, 24 hour-a-day surveillance by professional health care staff;
(7) may be mobile without human assistance but will regularly require the peformance of one or more simple specific nursing procedures more often than once daily - for example, giving of injectable medications, the change of surgical dressings, the treatment of pressure sores, the delivery of low-concentration, low-flow oxygen, catheter and ostomy care; or tube feeding (except when there is also a tracheostomy).

In addition to the above criteria for eligibility, applicants may demonstrate the following:

a. Communication - the applicant
   (1) may have difficulty expressing needs or be unable to express needs;
b. Personal Functions - the applicant
   (1) may require a varying amount of assistance with dressing, washing, grooming and bathing.
c. Mental Functions - the applicant
   (1) may or may not be mildly depressed or agitated;
   (2) may or may not have moderately impaired comprehension (ability to understand only simple instruction, short retention span);
   (3) may or may not demonstrate varying degrees of difficulty in orientation as to time, place and persons.
d. Medical Problems - in addition to those problems related to eligibility
   the applicant
   (1) will require monthly or more frequent visits by a physician;
   (2) may require a therapeutic diet;

(3) may require brief periods of individual Physio-or Occupational Therapy;

(4) may require professional monitoring and judgement on a continuing basis for a psychiatric problem (may not be available in all Extended Care Units);

(5) may be mobile without human assistance but exhibits gross fecal or urinary incontinence.

e. Social Functions - the applicant

(1) will require a home-like environment

(2) will require programs for social and recreational activities;

(3) may be attending social or educational facilities outside the Extended Care Unit (including vocational training).

Source: Administrative Manual - Long Term Care Program, British Columbia Ministry of Health, 1979.

APPENDIX B

Flow Diagram of Movement of Extended Care Clients (detailed version).

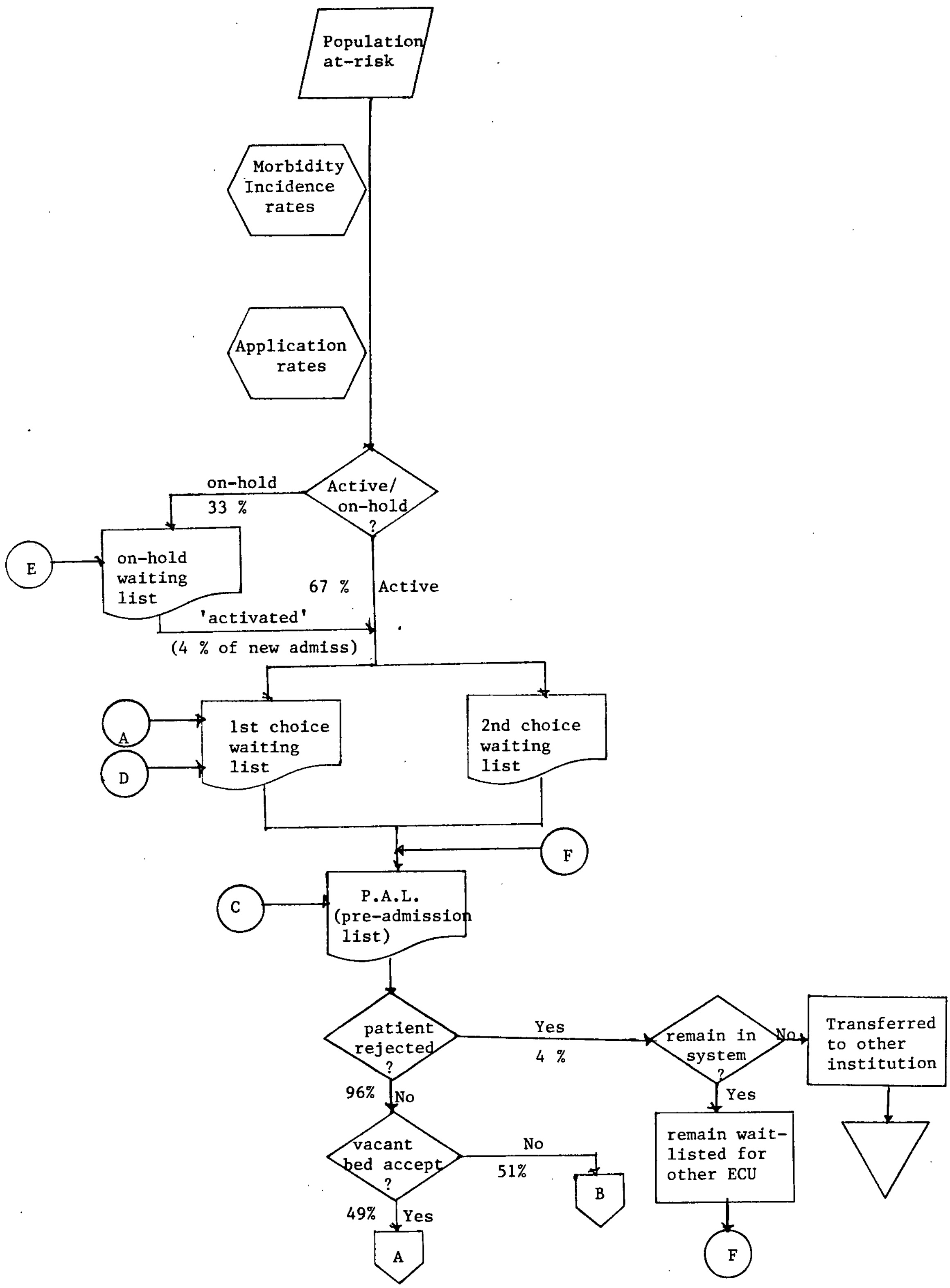

Figure 1. Detailed Flow Diagram of Movement of Extended Care Clients.

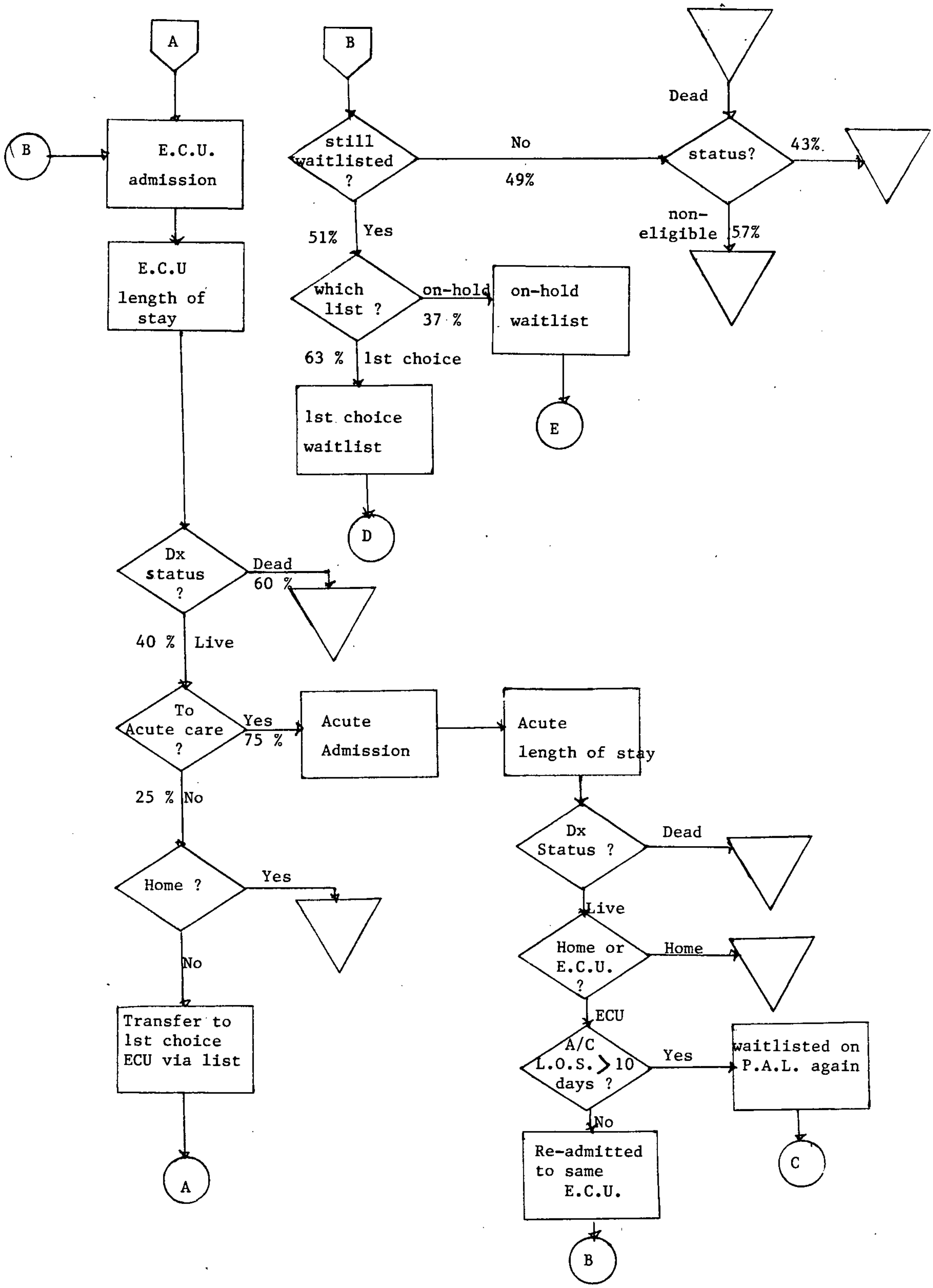

Figure 1. Detailed Flow Diagram of Movement of Extended Care Clients.

APPENDIX C

Distribution of lengths of stay of Extended Care patients
numbers and percentages)

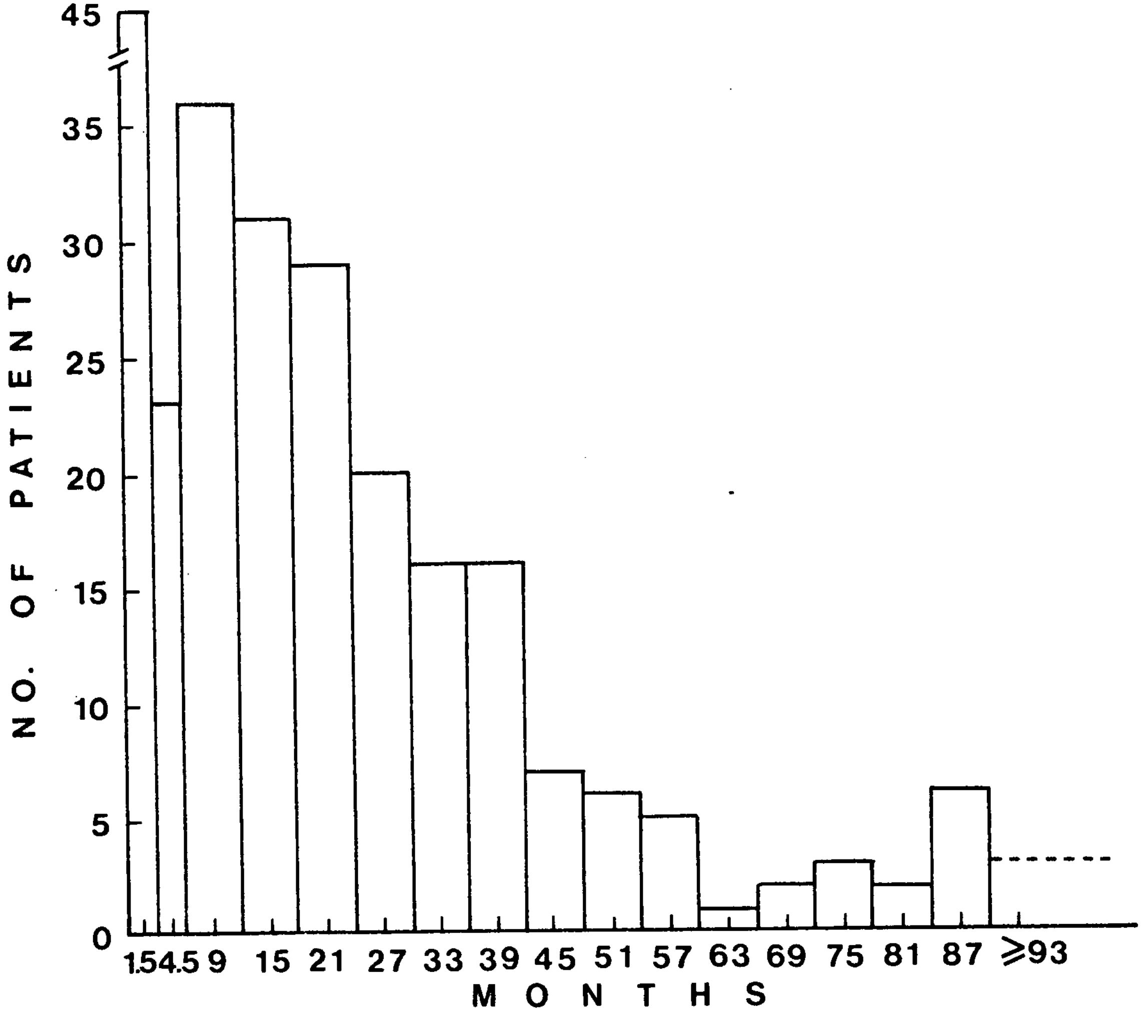

Figure 1. Distribution of Lengths of Stay of Extended Care Patients.
(Number of Patients)

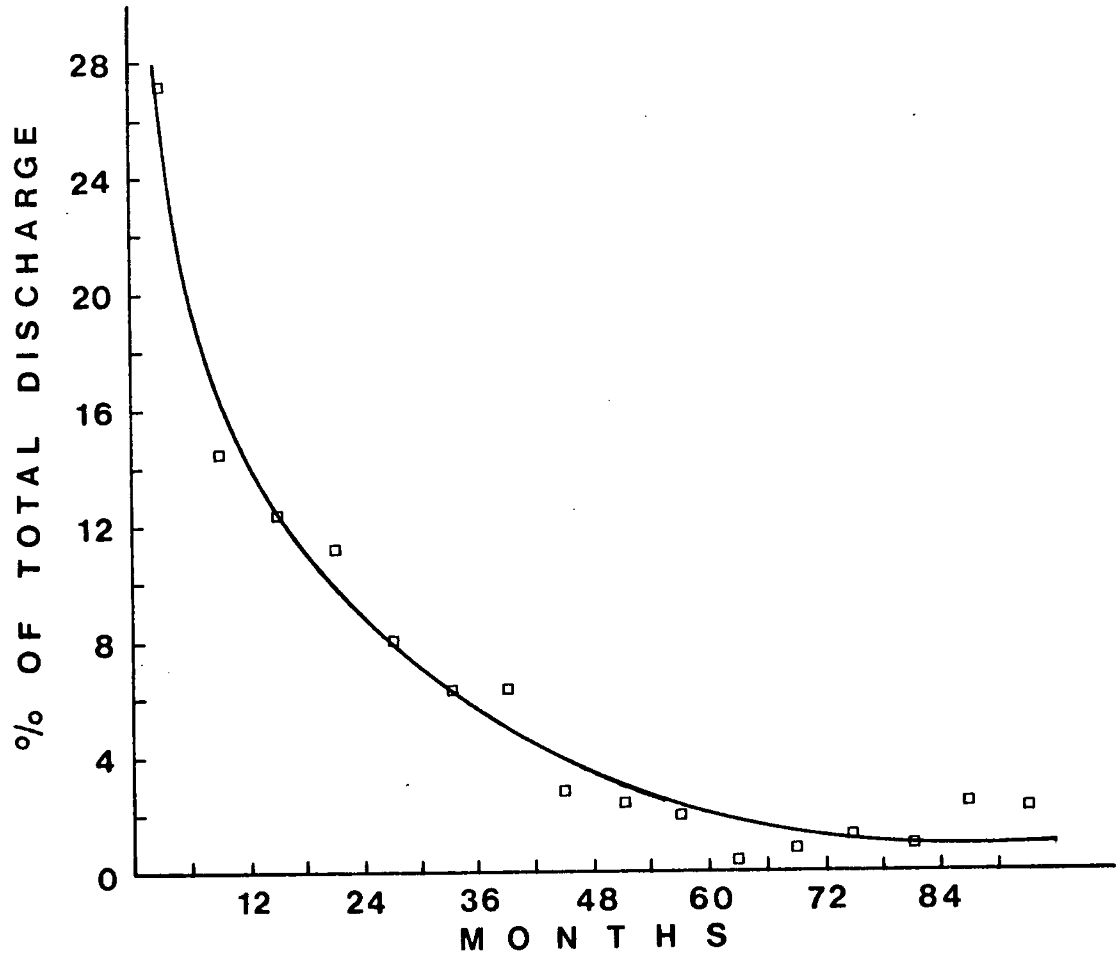

Figure 2. Distribution of Lengths of Stay of Extended Care Patients.
(Percent of total number of Patients Discharged)

APPRENDIX D

Computer printout of a typical simulation experiment.

```
$COMPILE
   0.4000000E 02           5 ADDED BEDS/MONTH
   0.5400000E 02          21 ADDED BEDS/MONTH
  -0.5000000E 02          25 ADDED BEDS/MONTH
   0.1250000E 03          33 ADDED BEDS/MONTH
  .0.3100000E 02          39 ADDED BEDS/MONTH
   0.0                    25 ADDED BEDS/MONTH
   0.3000000E 02          37 ADDED BEDS/MONTH
   0.3500000E 02          49 ADDED BEDS/MONTH
   0.3500000E 02          61 ADDED BEDS/MONTH
 BEDS      0.2506000E 04
 HOLX      0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
 NEWAX      0.1478000E 03     0.1515000E 03     0.1544000E 03     0.1573000E 03     0.1603000E 03     0.1636000E 03
 INITQ, Y     0.1186000E 04     0.4500000E 01
 YRCON          1980
 BEDS ADDED     0.0               0.0               0.0               0.0               0.4000000E 02     0.0               0.0
   0.0               0.0               0.0               0.0               0.0               0.0               0.0
   0.0               0.0               0.0               0.0               0.0               0.0               0.5400000E 02
   0.0               0.0               0.0              -0.5000000E 02     0.0               0.0               0.0
   0.0               0.0               0.0               0.0               0.1250000E 03     0.0               0.0
   0.0               0.3000000E 02     0.0               0.3100000E 02     0.0               0.0               0.0
   0.0               0.0               0.0               0.0               0.0               0.0               0.3500000E 02
   0.0               0.0               0.0               0.0               0.0               0.0               0.0
   0.0               0.0               0.0               0.0               0.3500000E 02     0.0               0.0
   0.0               0.0               0.0               0.0               0.0               0.0               0.0
   0.0               0.0
 HOLDS          0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01     0.3000000E 01
   0.3000000E 01     0.3000000E 01
 NEW APPS       0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1478000E 03
   0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1478000E 03     0.1515000E 03     0.1515000E 03
   0.1515000E 03     0.1515000E 03     0.1515000E 03     0.1515000E 03     0.1515000E 03     0.1515000E 03     0.1515000E 03
   0.1515000E 03     0.1515000E 03     0.1515000E 03     0.1544000E 03     0.1544000E 03     0.1544000E 03     0.1544000E 03
   0.1544000E 03     0.1544000E 03     0.1544000E 03     0.1544000E 03     0.1544000E 03     0.1544000E 03     0.1544000E 03
   0.1544000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03
   0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1573000E 03     0.1603000E 03
   0.1603000E 03     0.1603000E 03     0.1603000E 03     0.1603000E 03     0.1603000E 03     0.1603000E 03     0.1603000E 03
   0.1603000E 03     0.1603000E 03     0.1603000E 03     0.1603000E 03     0.1636000E 03     0.1636000E 03     0.1636000E 03
   0.1636000E 03     0.1636000E 03     0.1636000E 03     0.1636000E 03     0.1636000E 03     0.1636000E 03     0.1636000E 03
   0.1636000E 03     0.1636000E 03
 YEAR           1981    MONTH             1 BEDS AT START      0.2506000E 04
 NEW BEDS        0.0
 CASE  1
 BEDS AT END      0.2506000E 04   AVG WAIT OF THOSE ON Q      0.4430352E 01
 AVG WAIT OF DEPARTERS      0.9000000E 01 FINAL Q LENGTH      0.1191267E 04
 YEAR           1981    MONTH             2 BEDS AT START      0.2506000E 04
 NEW BEDS        0.0
 CASE  1
 BEDS AT END      0.2506000E 04   AVG WAIT OF THOSE ON Q      0.4372292E 01
 AVG WAIT OF DEPARTERS      0.8860704E 01 FINAL Q LENGTH      0.1197181E 04
 YEAR           1981    MONTH             3 BEDS AT START      0.2506000E 04
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NEW BEDS       0.0
CASE  1
BEDS AT END      0.2506000E 04  AVG WAIT OF THOSE ON Q      0.4324499E 01
AVG WAIT OF DEPARTERS     0.8744583E 01 FINAL Q LENGTH     0.1203637E 04
YEAR              1981   MONTH                4 BEDS AT START      0.2506000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2506000E 04  AVG WAIT OF THOSE ON Q      0.4285782E 01
AVG WAIT OF DEPARTERS     0.8648998E 01 FINAL Q LENGTH     0.1210537E 04
YEAR              1981   MONTH                5 BEDS AT START      0.2506000E 04
NEW BEDS       0.4000000E 02
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4254069E 01
AVG WAIT OF DEPARTERS     0.8571564E 01 FINAL Q LENGTH     0.1215506E 04
YEAR              1981   MONTH                6 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4228571E 01
AVG WAIT OF DEPARTERS     0.8508139E 01 FINAL Q LENGTH     0.1220776E 04
YEAR              1981   MONTH                7 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4208568E 01
AVG WAIT OF DEPARTERS     0.8457142E 01 FINAL Q LENGTH     0.1226287E 04
YEAR              1981   MONTH                8 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4193421E 01
AVG WAIT OF DEPARTERS     0.8417135E 01 FINAL Q LENGTH     0.1231986E 04
YEAR              1981   MONTH                9 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4182549E 01
AVG WAIT OF DEPARTERS     0.8386843E 01 FINAL Q LENGTH     0.1237829E 04
YEAR              1981   MONTH               10 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4175437E 01
AVG WAIT OF DEPARTERS     0.8365097E 01 FINAL Q LENGTH     0.1243775E 04
YEAR              1981   MONTH               11 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4171625E 01
AVG WAIT OF DEPARTERS     0.8350874E 01 FINAL Q LENGTH     0.1249788E 04
YEAR              1981   MONTH               12 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4170697E 01
AVG WAIT OF DEPARTERS     0.8343250E 01 FINAL Q LENGTH     0.1255838E 04
YEAR              1982   MONTH               13 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4161550E 01
AVG WAIT OF DEPARTERS     0.8341394E 01 FINAL Q LENGTH     0.1265596E 04
YEAR              1982   MONTH               14 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4157440E 01
AVG WAIT OF DEPARTERS     0.8323099E 01 FINAL Q LENGTH     0.1275440E 04
YEAR              1982   MONTH               15 BEDS AT START      0.2546000E 04
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NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4157701E 01
AVG WAIT OF DEPARTERS     0.8314880E 01 FINAL Q LENGTH     0.1285323E 04
YEAR            1982   MONTH              16 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4161743E 01
AVG WAIT OF DEPARTERS     0.8315403E 01 FINAL Q LENGTH     0.1295204E 04
YEAR            1982   MONTH              17 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4169045E 01
AVG WAIT OF DEPARTERS     0.8323486E 01 FINAL Q LENGTH     0.1305047E 04
YEAR            1982   MONTH              18 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4179152E 01
AVG WAIT OF DEPARTERS     0.8338091E 01 FINAL Q LENGTH     0.1314821E 04
YEAR            1982   MONTH              19 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4191660E 01
AVG WAIT OF DEPARTERS     0.8358305E 01 FINAL Q LENGTH     0.1324499E 04
YEAR            1982   MONTH              20 BEDS AT START      0.2546000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2546000E 04  AVG WAIT OF THOSE ON Q      0.4206214E 01
AVG WAIT OF DEPARTERS     0.8383320E 01 FINAL Q LENGTH     0.1334058E 04
YEAR            1982   MONTH              21 BEDS AT START      0.2546000E 04
NEW BEDS       0.5400000E 02
CASE  1
BEDS AT END      0.2600000E 04  AVG WAIT OF THOSE ON Q      0.4221388E 01
AVG WAIT OF DEPARTERS     0.8412428E 01 FINAL Q LENGTH     0.1340403E 04
YEAR            1982   MONTH              22 BEDS AT START      0.2600000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2600000E 04  AVG WAIT OF THOSE ON Q      0.4237054E 01
AVG WAIT OF DEPARTERS     0.8442776E 01 FINAL Q LENGTH     0.1346602E 04
YEAR            1982   MONTH              23 BEDS AT START      0.2600000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2600000E 04  AVG WAIT OF THOSE ON Q      0.4253096E 01
AVG WAIT OF DEPARTERS     0.8474108E 01 FINAL Q LENGTH     0.1352649E 04
YEAR            1982   MONTH              24 BEDS AT START      0.2600000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2600000E 04  AVG WAIT OF THOSE ON Q      0.4269412E 01
AVG WAIT OF DEPARTERS     0.8506191E 01 FINAL Q LENGTH     0.1358541E 04
YEAR            1983   MONTH              25 BEDS AT START      0.2600000E 04
NEW BEDS      -0.5000000E 02
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4278909E 01
AVG WAIT OF DEPARTERS     0.8538824E 01 FINAL Q LENGTH     0.1370036E 04
YEAR            1983   MONTH              26 BEDS AT START      0.2550000E 04
NEW BEDS       0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4291371E 01
AVG WAIT OF DEPARTERS     0.8557817E 01 FINAL Q LENGTH     0.1381442E 04
YEAR            1983   MONTH              27 BEDS AT START      0.2550000E 04
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NEW BEDS        0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4306376E 01
AVG WAIT OF DEPARTERS     0.8582743E 01 FINAL Q LENGTH     0.1392729E 04
YEAR            1983   MONTH              28 BEDS AT START     0.2550000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4323552E 01
AVG WAIT OF DEPARTERS     0.8612753E 01 FINAL Q LENGTH     0.1403875E 04
YEAR            1983   MONTH              29 BEDS AT START     0.2550000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4342565E 01
AVG WAIT OF DEPARTERS     0.8647104E 01 FINAL Q LENGTH     0.1414857E 04
YEAR            1983   MONTH              30 BEDS AT START     0.2550000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4363122E 01
AVG WAIT OF DEPARTERS     0.8685129E 01 FINAL Q LENGTH     0.1425660E 04
YEAR            1983   MONTH              31 BEDS AT START     0.2550000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4384968E 01
AVG WAIT OF DEPARTERS     0.8726244E 01 FINAL Q LENGTH     0.1436268E 04
YEAR            1983   MONTH              32 BEDS AT START     0.2550000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2550000E 04  AVG WAIT OF THOSE ON Q      0.4407874E 01
AVG WAIT OF DEPARTERS     0.8769936E 01 FINAL Q LENGTH     0.1446669E 04
YEAR            1983   MONTH              33 BEDS AT START     0.2550000E 04
NEW BEDS        0.1250000E 03
CASE  1
BEDS AT END      0.2675000E 04  AVG WAIT OF THOSE ON Q      0.4429269E 01
AVG WAIT OF DEPARTERS     0.8815748E 01 FINAL Q LENGTH     0.1449636E 04
YEAR            1983   MONTH              34 BEDS AT START     0.2675000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2675000E 04  AVG WAIT OF THOSE ON Q      0.4449255E 01
AVG WAIT OF DEPARTERS     0.8858538E 01 FINAL Q LENGTH     0.1452391E 04
YEAR            1983   MONTH              35 BEDS AT START     0.2675000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2675000E 04  AVG WAIT OF THOSE ON Q      0.4467921E 01
AVG WAIT OF DEPARTERS     0.8898510E 01 FINAL Q LENGTH     0.1454947E 04
YEAR            1983   MONTH              36 BEDS AT START     0.2675000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2675000E 04  AVG WAIT OF THOSE ON Q      0.4485353E 01
AVG WAIT OF DEPARTERS     0.8935843E 01 FINAL Q LENGTH     0.1457318E 04
YEAR            1984   MONTH              37 BEDS AT START     0.2675000E 04
NEW BEDS        0.3000000E 02
CASE  1
BEDS AT END      0.2705000E 04  AVG WAIT OF THOSE ON Q      0.4493112E 01
AVG WAIT OF DEPARTERS     0.8970707E 01 FINAL Q LENGTH     0.1460675E 04
YEAR            1984   MONTH              38 BEDS AT START     0.2705000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2705000E 04  AVG WAIT OF THOSE ON Q      0.4501123E 01
AVG WAIT OF DEPARTERS     0.8986223E 01 FINAL Q LENGTH     0.1463954E 04
YEAR            1984   MONTH              39 BEDS AT START     0.2705000E 04
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NEW BEDS        0.3100000E 02
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4508728E 01
AVG WAIT OF DEPARTERS      0.9002247E 01 FINAL Q LENGTH     0.1465352E 04
YEAR             1984   MONTH            40 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4515945E 01
AVG WAIT OF DEPARTERS      0.9017456E 01 FINAL Q LENGTH     0.1466673E 04
YEAR             1984   MONTH            41 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4522792E 01
AVG WAIT OF DEPARTERS      0.9031891E 01 FINAL Q LENGTH     0.1467920E 04
YEAR             1984   MONTH            42 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4529288E 01
AVG WAIT OF DEPARTERS      0.9045584E 01 FINAL Q LENGTH     0.1469098E 04
YEAR             1984   MONTH            43 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4535449E 01
AVG WAIT OF DEPARTERS      0.9058577E 01 FINAL Q LENGTH     0.1470210E 04
YEAR             1984   MONTH            44 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4541289E 01
AVG WAIT OF DEPARTERS      0.9070898E 01 FINAL Q LENGTH     0.1471259E 04
YEAR             1984   MONTH            45 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4546827E 01
AVG WAIT OF DEPARTERS      0.9082579E 01 FINAL Q LENGTH     0.1472249E 04
YEAR             1984   MONTH            46 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4552076E 01
AVG WAIT OF DEPARTERS      0.9093655E 01 FINAL Q LENGTH     0.1473183E 04
YEAR             1984   MONTH            47 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4557051E 01
AVG WAIT OF DEPARTERS      0.9104153E 01 FINAL Q LENGTH     0.1474063E 04
YEAR             1984   MONTH            48 BEDS AT START      0.2736000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2736000E 04  AVG WAIT OF THOSE ON Q      0.4561763E 01
AVG WAIT OF DEPARTERS      0.9114101E 01 FINAL Q LENGTH     0.1474892E 04
YEAR             1985   MONTH            49 BEDS AT START      0.2736000E 04
NEW BEDS        0.3500000E 02
CASE  1
BEDS AT END      0.2771000E 04  AVG WAIT OF THOSE ON Q      0.4557279E 01
AVG WAIT OF DEPARTERS      0.9123526E 01 FINAL Q LENGTH     0.1476634E 04
YEAR             1985   MONTH            50 BEDS AT START      0.2771000E 04
NEW BEDS        0.0
CASE  1
BEDS AT END      0.2771000E 04  AVG WAIT OF THOSE ON Q      0.4553899E 01
AVG WAIT OF DEPARTERS      0.9114557E 01 FINAL Q LENGTH     0.1478421E 04
YEAR             1985   MONTH            51 BEDS AT START      0.2771000E 04
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NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4545682E 01
AVG WAIT OF DEPARTERS      0.9097754E 01 FINAL Q LENGTH      0.1506072E 04
YEAR             1986    MONTH                64 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4543895E 01
AVG WAIT OF DEPARTERS      0.9091364E 01 FINAL Q LENGTH      0.1509240E 04
YEAR             1986    MONTH                65 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4543363E 01
AVG WAIT OF DEPARTERS      0.9087790E 01 FINAL Q LENGTH      0.1512427E 04
YEAR             1986    MONTH                66 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4543942E 01
AVG WAIT OF DEPARTERS      0.9086725E 01 FINAL Q LENGTH      0.1515619E 04
YEAR             1986    MONTH                67 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4545506E 01
AVG WAIT OF DEPARTERS      0.9087885E 01 FINAL Q LENGTH      0.1518806E 04
YEAR             1986    MONTH                68 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4547938E 01
AVG WAIT OF DEPARTERS      0.9091013E 01 FINAL Q LENGTH      0.1521976E 04
YEAR             1986    MONTH                69 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4551129E 01
AVG WAIT OF DEPARTERS      0.9095877E 01 FINAL Q LENGTH      0.1525120E 04
YEAR             1986    MONTH                70 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4554984E 01
AVG WAIT OF DEPARTERS      0.9102259E 01 FINAL Q LENGTH      0.1528231E 04
YEAR             1986    MONTH                71 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4559415E 01
AVG WAIT OF DEPARTERS      0.9109968E 01 FINAL Q LENGTH      0.1531303E 04
YEAR             1986    MONTH                72 BEDS AT START      0.2806000E 04
NEW BEDS       0.0
CASE 1
BEDS AT END      0.2806000E 04  AVG WAIT OF THOSE ON Q      0.4564341E 01
AVG WAIT OF DEPARTERS      0.9118830E 01 FINAL Q LENGTH      0.1534328E 04
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APPRENDIX E

Listing of Computer Program

LISTING OF BMONTHLY AT 12:23:58 ON JUN 18, 1981 FOR CCID=CLOG

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$COMPILE
C       VARIABLES ARE DEFINED AS THEY ARE USED
          INTEGER YRCON
        REAL NEWAP(72),HOLD(72),ADBED(72),NEWAX(6),HOLX(6)
        REAL INFLO, LEFTW,INITW,OTFLO,INITQ,MOFLO
C
C
        READ, BEDS
C       ENSURE THAT THE ADBED ARRAY IS INITIALLY EMPTY
          DO 52 I=1,72
        52 ADBED(I)=0.
C       NEW BEDS CAN BE ADDED TO
C       THE MODEL, A MONTH VALUED 9999 STOPS THE
C       SEARCH FOR NEW BEDS TO ADD.
C       NUMBER OF BEDS IS FOLLOWED BY MONTH WITH
C       JANUARY 81 BEING MONTH 1, ONE SET OF DATA
C         PER LINE
          DO 50 I=1,72
          READ,ADDED,MO
          IF (MO.EQ.9999) GO TO 51
          ADBED(MO)=ADBED(MO)+ADDED
          PRINT,ADDED,MO, 'ADDED BEDS/MONTH'
        50 CONTINUE
        51 CONTINUE
C       HOLX IS THE NUMBER OF HOLDS/MO IN YEAR K
C       NEWAX IS THE NUMBER OF NEW APPLICANTS/MO IN YEAR K
          READ HOLX
          READ NEWAX
C       Y IS THE INITIAL WAIT TO DATE IN Q AT START OF MONTH.
C         INITQ IS THE INITIAL QUEUE LENGTH AT THE START OF THE FIRST MONTH.
          READ, INITQ,Y
C       IG IS A FLAG FOR DEBUG PRINTING IF SET TO 1
          READ, IG
          READ, YRCON
          PRINT, 'BEDS', BEDS
          PRINT, 'HOLX', HOLX
          PRINT, 'NEWAX', NEWAX
          PRINT, 'INITQ, Y', INITQ,Y
          PRINT, 'YRCON', YRCON
C       CONVERT DATA INTERNALLY FROM YEARLY DATA TO MONTHLY.
C       NOTE THAT THIS IS A PSEUDO-MONTHLY MODEL
          DO 15 J=1,72
          K =(J-1)/12+1
          NEWAP(J)=NEWAX(K)
          HOLD(J)=HOLX(K)
        15 CONTINUE
C       AT THIS POINT ADD ANY SPECIAL CODE TO CHANGE
C         ANY OF THE MONTHLY RATES.
          PRINT, 'BEDS ADDED', ADBED
          PRINT, 'HOLDS      ', HOLD
          PRINT, "NEW APPS  ',NEWAP
C       SET UP MONTH COUNTER
          DO 5 J=1,72
C         COMPUTE THE YEAR IN WHICH MONTH FALLS
          I=(J-1)/12+1
C       COMPUTE YEAR FROM BASE YEAR YRCON
          IYR=YRCON+1
          PRINT, 'YEAR', IYR, 'MONTH',J, 'BEDS AT START  ', BEDS
```

LISTING OF BMONTHLY AT 12:23:58 ON JUN 18, 1981 FOR CCID=CLOG

```
            PRINT, 'NEW BEDS', ADBED(J)
C       COMPUTE BEDS AT START OF MONTH
            BEDS=BEDS+ADBED(J)
C           ELOS=30.3 MONTHS
C       DISCH/MO= ((AVG BEDS*.98)/(ELOS/12))/12
C           COMPUTE THE NUMBER OF ADMISSIONS THIS MONTH
            ADMIS=((BEDS*.98)/(30.3/12.0))/12.0
            IF(IG.EQ.1) PRINT, 'ADMISSIONS',ADMIS, ' BEDS ', BEDS
C       ADJUSTED OF COURSE FOR THOSE WHO ARE REJECTED, ETC.
C           .01155 OF THOSE SCREENED DIE FOR EACH MONTH THEY ARE IN
C                THE ACTIVE WAITING LIST, 0.01544 ARE FOUND INELIGIBLE
C           FOR EACH MONTH ON THE WAITING LIST.
C       WE CAN THUS ESTIMATE THE PERCENTAGE OF THOSE SCREENED THAT ARE
C       DECEASED OR FOUND INELIGIBLE BY MULTIPLYING THE SUM OF
C       THESE PERCENTAGES BY 2Y, THE AVERAGE WAIT OF APPLICANTS ON
C       SCREENING.
            ZZ=2.0*Y*(.01155+.01544)
C       IT IS ASSUMED THAT THIS VALUE Z IS THE PERCENTAGE OF THOSE
C           SCREENED THAT ARE EXCLUDED FOR THESE REASONS, BUT THAT
C           THE OTHER PROPORTIONS ARE NOT AFFECTED, THUS IF THERE
C           WERE NO QUEUE, THOSE SCREENED OUT DUE TO DEATH, OR BEING
C           FOUND INELIGIBLE WOULD BE ZERO, NEW ADMISSIONS
C           WOULD STILL BE 47%, THOSE GOING TO THE ON-HOLD LIST WOULD
C           STILL BE 9.2%, THOSE MOVED OR REJECTED 3.9%.
C            THOSE RETURNED TO THE ACTIVE LIST WOULD STILL BE
C           15.7%---WHEN VIEWED AS PROPORTIONS.  THUS THE PROPORTION
C           OF SCREENED PEOPLE TAKEN OFF THE LIST RELATIVE TO THE
C           NUMBER OF ADMITTED TO ECU BEDS WOULD THEN BE
C              (.092+.039)/.47
            XX=(ZZ+.092+.039)/.47
            OTFLO=ADMIS*(1.0+XX)
            IF (IG.EQ.1)PRINT, ' XX ', XX, 'OTFLO', OTFLO, 'ZZ', ZZ
C       COMPUTE MONTHLY INFLO
            INFLO= HOLD(J)+NEWAP(J)
            IF(IG.EQ.1) PRINT, 'INFLO', INFLO, 'HOLD', HOLD(J),
       1 'NEWAP ', NEWAP(J)
C       QUEUE AT THE END OF MONTH
            MOFLO=(INFLO - OTFLO)
            IF (IG.EQ.1) PRINT, 'MOFLO', MOFLO
            IF (MOFLO.GE.0) GO TO 68
            A =-MOFLO
            IF (INITQ.GE.A) FINQ=INITQ + MOFLO
            IF (INITQ.LT.A) FINQ=0
C
            GO TO 69
        68 FINQ=INITQ+MOFLO
C       COMPUTE AVERAGE QUEUE
            69 AVGQ=(FINQ+INITQ)/2.0
C
C
C       WAITING TIME CALCULATIONS
C
C
C       COMPUTE MONTHS TO EXHAUST INITIAL QUEUE
C
            B=INITQ/OTFLO
            IF (IG.EQ.1) PRINT, 'B',B
            IF (B.LT.1.0) GO TO 2
```

LISTING OF BMONTHLY AT 12:23:58 ON JUN 18, 1981 FOR CCID=CLOG

```
C
C      CASE 1
         PRINT, 'CASE 1'
C      AVG WAIT OF THOSE WHO LEFT QUEUE DURING MONTH
         LEFTW=2*Y
C      AVG WAIT OF NEW APPS IS 1/2 MONTH
C      THE NUMBER OF NEW APPLICANTS IS
         APPS=INFLO
         IF(IG.EQ.1) PRINT, 'APPS', APPS
C        AVERAGE FLOW--AN APPROX MEASURE OF RATE OF MOVEMENT, LINE BUILDUP
         AVFLO=(INFLO+OTFLO)/2.0
C      AVG WAIT OF LAST FELLOW IN Q AT START OF MONTH
         F=0.0
C      AT END F CURRENT MONTH
         F=F+1.0
C      AVG WAIT F THE GUY WHO ENDS UP AT THE HEAD OF
C      THE LINE WHEN THE CURRENT MONTH ENDS.
         G=2.0*Y
         IF (IG.EQ.1) PRINT, 'AVFLO,F,G', AVFLO,F,G
C      AVG WAIT F ALL THE FOLKS LEFT OVER
         XAVG=(G+F)/2.0
C      WEIGHTED AVG WAIT AT START OF NEXT MONTH FOR THOSE ON Q
         Y=(XAVG*(INITQ-OTFLO)+APPS*0.5)/(INITQ-OTFLO+APPS)
         GO TO 6
C
C      CASE 2
       2 CONTINUE
         PRINT, 'CASE2'
C      AVG TIME IN Q FOR THOSE IN INITIALLY BUT WHO LEFT IS
C        AVG WAIT TO DATE AT START OF MONTH PLUS AVG WAIT
C        DURING THE MONTH
         INITW=2.0*Y
C      PARTIAL MONTH OF INFLO TO MEET 1-B MONTHS OF OUTFLO
         C=(OTFLO-INITQ)/INFLO
C      AVG TIME IN QUEUE FOR THOSE WHO JOINED THE Q AND LEFT SAME MONTH
         D=(1.0-C+B)/2.0
C      AVERAGE TIME IN Q FOR THOSE WHO JOINED THIS MONTH AND STAYED
         Y=(1.0-C)/2.0
C      AVG WAIT FOR ALL THOSE WHO LEFT
         LEFTW=((D*(1.0-B)*OTFLO)+(INITW*B*OTFLO))/(OTFLO)
         IF(IG.EQ.1) PRINT, 'C', C, 'D', D, 'Y', Y
       1, 'INITW', INITW, 'LEFTW', LEFTW
C      PRINT RESULTS
         6 PRINT, 'BEDS AT END', BEDS, 'AVG WAIT OF THOSE ON Q ', Y
            PRINT, 'AVG WAIT OF DEPARTERS', LEFTW, 'FINAL Q LENGTH', FINQ
C      INITIAL AVG WAIT TO DATE AND INIT. Q LENGTH FOR NEXT MONTH CALCULA-
         TIONS
C        STOP AFTER SIX YEARS/72 MONTHS
         5 INITQ=FINQ
         STOP
         END
        $EXECUTE
```