TRENDS IN LABORATORY UTILIZATION IN BRITISH COLUMBIA HOSPITALS - 1966 TO 1980; IMPLICATIONS FOR MANPOWER PLANNING

BY

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ABSTRACT

One might expect that there are a number of factors that influence the demand for laboratory services including changes in population, physician supply, the delivery system, changing technology, and the availability of a skilled workforce. Similarly, the supply of laboratory services is affected by the supply of available manpower, particularly physicians, and the amount of capital flowing into the health care sector of the economy. Trends in the utilization of laboratory services have a substantial impact on manpower use in this sector of the health care system. In order to prepare appropriate manpower projections for laboratory personnel, planners must consider the impact of trends in the above factors.

This study presents an analysis of data showing trends in the pattern of laboratory utilization in British Columbia public hospitals from 1966 to 1980 and relates these trends to changes in the above factors. Trends are identified by analyzing utilization data for each of 1966, 1970, 1974, 1978, and 1980. The primary source of data is the HS-1 Health and Welfare Canada statistical returns prepared annually by all hospitals. The analysis involves calculating percentage changes between each period in key utilization measurement parameters. Utilization measurement parameters include patient days per acute care admission, acute care admissions per bed, laboratory workload and expenses per patient day

and per acute care admission, and other parameters related to demographics, bed distribution, physician supply, and laboratory manpower supply. This analysis is put into the British Columbia context and discussed in relation to provincial policies and the development of the provincial health care delivery system.

Data are presented showing B.C.'s population to be aging and the impact of this trend on laboratory demand is discussed. It is shown that the acute care bed/population ratio decreased from 6.1/1,000 in 1962 to 4.3/1,000 in 1978 while the ratio of extended care beds increased from 0.4/1,000 to 2.2/1,000. It is also shown that there has been a general decrease in hospital activity related to Obstetrical and Pediatric services in B.C. hospitals from 1966 to 1980.

Physician supply is reported to have a substantial impact on the use of health care services, including laboratories, and B.C. is shown to have the highest ratio of general practitioners in Canada with one for every 578 people.

Automation has permitted more throughput per laboratory worker and helped keep the rise in laboratory operating expenses from increasing proportionately with workload. Laboratory expenses data show an increasing emphasis on supplies and a decreasing emphasis on medical salaries.

It was found that there were no large changes in the mix of laboratory personnel employed in B.C. hospitals throughout the period 1966 to 1980. Medical Laboratory Technologists generally comprise about 66% of the laboratory workforce. Technical

Assistants account for about 7% of the workforce and clerical staff comprise approximately 23% of the laboratory workforce.

Recommendations for improved data collection are made together with some observations related to better development and deployment of laboratory manpower.

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ACKNOWLEDGEMENTS

Several people have contributed to the completion of this project. I wish to first of all, extend my gratitude to my committee members, Dr. Anne Crichton, Dr. Lawrie Dunn, and Dr. Annette Stark, all of whom gave generously of their time in both personal discussions and reviews of the manuscript. Without their guidance, encouragement, and occassional prodding, this study could not have been completed.

I would also like to gratefully acknowledge the generous assistance of the staff of the Division of Health Services Research and Development at U.B.C., particularly that of Susan Chan, who provided much of the data for this study in usable form. My thanks also the the Ministry of Health for their permission to access the data and to the University affiliated teaching hospitals of Vancouver who allowed their data to be used in this study.

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CHAPTER 1

INTRODUCTION

There are several factors that influence laboratory utilization. Among these factors are:

1. the demand for laboratory services generated by a growing population changing in demographic composition,
2. the ability to supply the appropriate services through an adequate supply of qualified professionals, and
3. sufficient facilities to provide the services.

The purpose of this study is to review how these, and other factors, have contributed to the current pattern of laboratory utilization in British Columbia public hospitals and to speculate how changes in these areas affect manpower deployment in laboratories.

This study addresses four main questions related to the impact of the above factors on manpower utilization in laboratories:

1. What has been the effect of changing demographics on the demand for laboratory services?

2. What has been the effect of changing technology and automation on both the supply of, and demand for laboratory services?

3. What has been the effect of the supply of physicians on both the demand for laboratory services and the supply of laboratory services?

4. How has the supply and mix of laboratory manpower changed in response to changes in population, physician supply and technology?

Issues related to each of the above questions are reviewed, insofar as data were available, and analyzed in terms of their implications for planning.

In the chapters which follow, there is a discussion of the type of data available for analysis in this study as well as a brief discussion of data that would have been of interest but was not readily available for review. The study begins with a review of the historical development of the British Columbian health care delivery system and then moves into a discussion of issues related to the demand for laboratory services followed by issues related to the supply of these services. Data are presented which represent the development of laboratory utilization patterns in B.C. public hospitals from 1966 to 1980 and the patterns of utilization are discussed in terms of their implications for planning. Also included in these discussions is the effect of changes in laboratory technology and the role of physicians in both the demand and supply of laboratory services. This is followed by a discussion of manpower planning in general and a review of past and present efforts in B.C. in forecasting manpower needs in the health care sector. There is then a presentation of data showing the impact of the previously identified demand and supply issues on manpower utilization in laboratories and on laboratory operating expenses. The final chapter presents a summary of the study and draws the reader's attention to conclusions identified throughout the text of the study. There is also a brief discussion of some of the recommendations that could be considered by health care planners in coming to grips with the issue of controlling the use of laboratory services.

CHAPTER II

METHODOLOGY

This study is mainly descriptive but it presents an analysis of available data showing trends in the patterns of utilization of laboratories in British Columbia public hospitals after describing the evolution of health services and laboratories in British Columbia. The patterns are identified from an analysis of a variety of documents listed below and from discussions with experts in the field. Utilization data were collected for the period 1966 to 1980 and are discussed in relation to changes in medical practice, technological advancements, socio-economic conditions, and government policies existing prior to and during that time period. The impact of such changes on laboratory manpower utilization is discussed in relation to the visible effects on staffing patterns involving Laboratory Physicians, Laboratory Scientists, Medical Laboratory Technologists, Laboratory Technical Assistants, and Administrative Support Personnel.

The "Annual Return on Health Care Facilities - Parts I and II" (HS-1 and HS-2) is used as the primary source of data related to laboratory staffing patterns, laboratory workload patterns, hospital sizes and hospital activity for British Columbia hospitals. These data are used to calculate several productivity and workload indicators such as laboratory workload units per acute care admission and per patient day, laboratory costs per acute care admission and patient day, laboratory workload units per full time equivalent worker, and laboratory workload units per paid hour.

All data are grouped and analyzed both in total and by hospital size groups and hospital role. The categories are as follows:

1. Group I: 0-99 acute care beds

2. Group II: 100-199 acute care beds

3. Group III: 200-299 acute care beds

4. Group IV: over 300 acute care beds

5. Group V: University Affiliated Teaching Hospitals

It was considered that the use of laboratories, and hence the staffing of laboratories, could vary according to hospital size and role and therefore data should be analyzed according to these parameters. The size groupings were somewhat arbitrary. Although other studies had found data from hospitals of less than 100 beds of questionable use, it was decided to include these hopsitals in a separate group in order to complete the province-wide picture of laboratory workloads and laboratory staffing. The limitations of the data related to this group are discussed in the text where appropriate. Teaching hospitals are frequently acknowledged as having service utilization patterns different from non-teaching hospitals. In an attempt to identify differences in laboratory utilization and operation between teaching and non-teaching hospitals, it was decided to group the teaching hospitals together irrespective of their individual bed size. The other hospital size groups were selected by what seemed an appropriate size division that would group together small community hospitals in Group II, medium sized community hospitals providing some level of referral services in Group III, and the larger urban center hospitals providing a full range of community and regional referral services in Group IV. The number of hospitals in each hospital size group for each year of this study is presented in Appendix 9.

The HS-1 and HS-2 data were made available through the Division of Health Services Research and Development at the University of British Columbia. As individual hospital data remain the property of the hospitals, only aggregated data were released and those with the permission of the British Columbia Ministry of Health, Hospital Programs Division. Because the size of the University Affiliated Teaching Hospital group was so small and there was the possibility of identifying the source of the data, permission to use their data was obtained from each of Vancouver General Hospital, St. Paul's Hospital, Children's Hospital, and Shaughnessy Hospital.

Trends in laboratory utilization in B.C. hospitals are identified by examining data at four year intervals from 1966 to 1980; that is , data is presented only for 1966, 1970, 1974, 1978, and 1980. At the outset of this study, it was hoped to include data for the period 1960 to 1982. Such a time frame would include data prior to the introduction of Medicare which was believed to have had a significant impact on the use of health care facilities in B.C.

It was also expected that data from this time period would clearly show the impact of automation in laboratories in terms of workloads, manpower, and productivity over the last two decades. However, difficulty in obtaining data for the period prior to 1966 prevented the inclusion of those years in this study.

Because the current method of reporting laboratory workload was not introduced until 1968, data prior to that year only include financial and laboratory staffing information. It was thought that the present time frame would still show some degree of impact from the introduction of Medicare when comparisons are made between the 1966 data and that of the subsequent reporting years. There would also be some indication of the impact of technology and automation on laboratories based on the changes in this regard since 1966.

The HS-1 and HS-2 forms are statistical reports designed to provide "basic information of value to hospitals and provincial authorities"(1). These reports are to be completed by all "public, proprietary and federal hospitals in Canada, regardless of the hospital's status under the federal- provincial hospital insurance program" in accordance with the requirements of the Statistics Act (Section 21) and with Regulation 11 of the Hospital Insurance and Diagnostic Services Act(1).

During the period under review in this study, the format and instructions for the HS-1 and HS-2 returns underwent three separate revisions. Consequently, in some cases, full comparative analysis of data for the total period 1966-1980 was not possible. The areas where this occurred are identified in the text. It should also be noted that the reporting year changed from the calendar year to the fiscal year April 1 - March 31 in 1977. Therefore, two reporting years contain data derived from the fiscal year April to March while three reporting years contain data based on the calendar year. As data were not collected during the transition year, there are no cases where a reporting year exceeds 12 months.

Other sources of data include published material from a variety of researchers, Statistics Canada demographic reports, and personal discussions with a variety of professionals in related fields. The sources are duly cited in the text where appropriate and listed in the references.

It will be noted that this study excludes data related to the private sector laboratories in British Columbia. It is recognized that the absence of such data prevents a complete province-wide picture of laboratory utilization being presented; however, as many public hospitals provide laboratory services to ambulatory patients in competition with the private sector, the trends in laboratory utilization found in hospital laboratories in terms of workload and costs are likely very similar to those found in private sector laboratories. Other studies have attempted comparisons between public and private sector laboratories and noted dissimilarities in the type of information collected by these laboratories, making direct comparisons difficult at best. It was decided at the outset of this study that another attempt at comparisons between the private and public sector laboratories was beyond the scope and time-frame of this study.

It was considered that data related to changes in the type of laboratory tests ordered and the frequency with which tests are ordered would be of interest in such a study as this. Such information could possibly have been made available through the Medical Services Commission of British Columbia however, the time limitations of this study precluded this avenue being explored.

Another area of interest that could not be pursued in this study was related to the introduction of major automated analyzers into B.C. public hospitals. It would have been interesting to try to relate the introduction of such equipment with changes in laboratory productivity and the demand for laboratory services. An important question to consider is whether the demand for some laboratory services is increased through the ability of laboratories to supply increased services. A request of the B.C. Ministry of Health for data related to the acquisition of such equipment found that such information was not readily available from the Equipment Secretariat.

CHAPTER III

BACKGROUND

Over the last forty years, British Columbia has experienced significant changes in its health care system: the introduction of hospital insurance and medicare; the expansion of health professionals' education encouraged through federal grants; advancements in medical sciences from new surgical procedures to new laboratory and radiological diagnostic and treatment methods; and dramatic changes in health technology and the philosophy of medical practice. These changes have had varying effects on the health care system in terms of what the system can provide and what the public expects.

In order to provide the public with the state-of-the-art health care they expect, it has become practice to train and employ highly skilled health care professionals. In order to provide the level of service desired in the most cost effective manner possible, there has been a division of labour in the health care industry. The division is such that there are several levels of expertise and care facilities available, such that the most highly trained individuals are not performing the most elementary of tasks and relatively well patients are not occupying the most expensive treatment beds. This layering of health professionals and health institutions is evident in all areas of the health sector including medical laboratories. In this setting, the most highly trained personnel are the Laboratory Physicians while perhaps the least trained personnel are Laboratory Technical Assistants. Each has a specific role to play in ensuring that high standards in the practice of laboratory medicine are provided while at the same time, work is being performed in the most cost-effective and cost- beneficial manner.

With the dramatic developments in medical technology and medical practice in the last twenty years, one would expect to see changes in the number of laboratory personnel as well as in the type and function of manpower groups.

THE COST OF CANADA'S HEALTH CARE SERVICES

It is generally recognized that the cost of health care in Canada is increasing at rates exceeding other sectors of the economy. Canada-wide, health expenditures per person increased from $120.34 in 1960 to $1057.58 in 1981.(2,3) In terms of inflation adjusted dollars, the increase was from $171.42 in 1960 to $478.54 in 1981 using standard 1971 dollars. For British Columbia, the projected 1981 figure is $1,310.75, or $524.15 in 1971 dollars, making it third highest in the country following the Territories and Alberta.(3) The adjustment for inflation was calculated by dividing current expenditures by the value of current dollars indexed to 1971 dollars. The inflation indices are as reported by Statistics Canada for Health and Personal Care.(4)

In terms of Gross National Product, health expenditures in Canada rose from 5.6% in 1960 to 7.0% in 1978.(5,6) They have remained relatively constant throughout the last decade, since the introduction of Medicare, ranging from a low in 1974 of 6.7% to a high of 7.3% in 1971.(6) By comparison, national health expenditures in the U.S. in 1978 accounted for 8.9% of their Gross National Product, up from 7.6% in 1970.(6)

A review of total health care expenditures in Canada by category of expense, shows that total expenditures increased from $6.1 billion in 1970 to $16.2 billion in 1978 for a net increase of 166%. Hospital expenditures increased from $2.8 billion in 1970 to $7.3 billion in 1978 representing an increase of 161%. Payments to physicians increased from $1.0 billion in 1970 to $3.7 billion in 1978 representing an increase of 270%. In terms of consumer price index adjusted 1971 dollars the total expenditures increased form $6.22 billion to $9.75 billion, or 57%, for the same period, hospital expenditures increased from $2.86 billion to $4.39 billion, or 53%, and physician payments increased from $.98 billion to $2.23 billion, or 128%, for the period 1970 to 1978.(7)

It has been suggested that laboratory services account for approximately 10% of the total hospital budget and that their share of the hospital budget has been increasing annually in some institutions.(8) As laboratories represent an increased proportion of the overall hospital budget, and the dollar value of laboratory services have become of increasing significance, they are receiving more attention from governments and hospital administrators as areas for potential improvements in operating efficiency and utilization patterns.

THE HEALTH CARE DELIVERY SYSTEM IN B.C.

The health care delivery system in British Columbia has evolved to its present state through a series of incremental moves over the last 60 years. As early as 1919, a British Columbia Royal Commission reviewed the possibility of state health insurance. Its recommendation was for a province-wide pre-paid compulsory program for wage earners below a basic minimum ($3000.00 per annum). Those earning more than the minimum amount would still have access only to private insurance.

The British Columbia government appointed a Royal Commission on Health Insurance and Maternity Benefits in 1929. The Commission's report resulted in the enactment of the Health Insurance Act. This legislation was passed in 1936 to provide a form of comprehensive health insurance but it was never implemented. The halt of this legislation was due largely to protests expressed by the B.C. Medical Association and protests by a large section of the business community who claimed that the economy could not stand social legislation at that time.(9)

During the 1930's and 1940's, a variety of private, pre-paid medical plans were brought into existence in B.C. These plans had the support of B.C. physicians through the B.C.M.A. which felt the plans adequately serviced the target population, (ie. the employed) and comprehensively covered the great majority of medical services rendered by physicians. These plans were often established in consultation with the B.C.M.A. and, in some cases, were sponsored by physicians. The problem with these plans was that the premiums were prohibitively high for many workers and there was no coverage for the poor and the geriatric population.(9)

In 1948, the first steps toward a national health plan were taken by the federal government when it introduced The National Health Grants Act. This established a federal grant-in-aid program to assist provinces in extending and improving public health and hospital services. The federal government laid down standards of construction for hospital facilities, and program principles and then provided money for specific projects on a matching basis with joint federal-provincial administration.(10)

In order to avail themselves of these particular grants, the provinces had to develop plans in which they could forecast hospital developments as part of a comprehensive health care delivery program. British Columbia engaged the services of a Minnesota-based consulting firm to prepare the provincial hospital construction and manpower plan (Hamilton Report).(11) The objectives of the study were to determine the provincial bed requirements to 1951 and 1971 and to lay down a plan of how to meet those requirements. The study was also to estimate the number of health care professionals and para-professionals that would be needed and to recommend a plan to train them.

Hamilton found the province's hospitals generally in a poor state of repair, being poorly designed, aged, fire hazards, and often over-crowded. The recommendations were for the immediate addition of 2,864 new beds by 1951 and a further 6,244 beds between 1951 and 1971 of which 4204 would be new beds and 2040 would replace existing beds. The report also recommended the division of the province into six primary health regions and the classification and development of hospitals according to an organized referral pattern. The classification of hospitals was to include: community clinics and health centres, community hospitals, regional hospitals, and teaching or base hospitals. Each region was to include at least one regional or base hospital which would provide referral services not provided elsewhere in the region.(11)

The Hamilton Report recognized the short supply of physicians, nurses, and laboratory technologists, and recommended levels of enrollment in the province's training institutions that would alleviate the shortage. The specific recommendations related to manpower are discussed in more detail in Chapter VI.

After the hospital construction plan was accepted at provincial and federal levels, it became a very loose general guideline for hospital development as the plan was subject to political pressures for modification. The National Health Grants Act separated capital costs from operating costs. Single or joint municipalities which could raise 25% of the total capital cost of a hospital could then bring pressure to bear on the provincial government to raise another 25% and then seek the rest of the capital funding from Ottawa.

There was no intention that hospitals, other than mental or long term care hospitals, should be built or operated by governments. Grants were made available to Societies formed by local interest groups who would take responsibility for managing the hospitals. Building a local hospital became an important community project for many small towns. There was little concern regarding the difficulties of obtaining operating funds, particularly after the 1949 introduction of a provincial hospital insurance plan.

The introduction of the B.C. Hospital Insurance Act in 1949 to meet hospital operating costs, provided small communities with further impetus to lobby for more hospitals. The program was initially supported by premium payments which proved difficult to collect and publically unpopular. In 1954, premiums were abolished and the retail sales tax was raised by 2% to cover hospital costs. The mandate of the insurance plan excluded the costs of chronic care hospitals and outpatient services. This exclusion resulted in a growing misuse of acute care beds which were in very short supply. Patients who could not afford chronic care hospitals were often placed in acute care facilities. The development of this pattern of use of hospital beds seems to persist to a large degree today and may have been a contributing factor to the slow development of long term care facilities. It also served to encourage the use of hospitals for diagnostic services which could be provided in an ambulatory setting in either private or public facilities. Such services were covered by private insurance, however, as mentioned above, such coverage was frequently beyond the means of a large sector of the population and many people took out hospital insurance but not medical insurance.

The federal Hospital Insurance and Diagnostic Services Act was enacted in July 1958. It offered the provinces 50 per cent of the funds required to operate their own hospital plans, provided certain basic program principles were met. In order to participate in the program, the provinces were required to make insured services uniformly available to all their residents. Insured services included hospital per diem rates and specific diagnostic services such as laboratory and radiology. The funding formula was such that poor provinces received slightly more than 50% of their funds from Ottawa while richer provinces received slightly less than 50%.

Also in 1958, the B.C. government instituted the British Columbia Government Employees' Medical Society, a pre-paid medical insurance program available to all government employees both active and retired, with the government paying half the premiums. This was the beginning of a province-wide pre-paid medical insurance program which became a reality with the introduction of the B.C. Medical Grant Act in 1965.

The objectives of the Medical Grant Act included the desire to provide a voluntary, non-profit medical insurance plan to any resident of the province who wished to apply. There were no restrictions or qualifications regarding age, state of health, or financial status and there was a provision for government financial assistance based on taxable income.(9) The only major restriction was that the plan was available to individuals only, not groups.

The B.C. Medical Plan was organized to carry out these objectives, collect premiums, pay claims and oversee the operation of the plan and was administered by a six-member Board of Directors consisting of three physicians nominated by the B.C.M.A. and three laymen. Under the new plan, physicians were paid on a fee-for-service basis according to an agreed fee schedule. A formal process was set up whereby fees were established by the physicians through the B.C.M.A. in negotiation with the government.

The B.C. Medical Plan became the Medical Services Plan of B.C. on July 1, 1968 with the introduction of the federal Medical Care Act. This Act required the federal government to pay one-half the cost of insured services in participating provinces. Insured services included all medically required services rendered by a physician or surgeon.

The development of the health care delivery system in this manner resulted in compartmentalization of services rather than a rational approach to delivery of adequate health care services. For example, hospital insurance had provided costly treatment and diagnostic services without direct charge to the patient if he was admitted to an acute care hospital, but required him to pay for services out of his own pocket, or through private insurance premiums, when not a hospital inpatient. Similarly, transfer of a patient to a less expensive extended care facility almost invariably meant greater direct costs to the patient because the hospital plan did not cover extended care services. This approach to insured health care services left gaps in some services and promoted over-utilization in others.

As diagnostic services were included as insured services under the Hospital Insurance and Diagnostic Services Act, hospital laboratories experienced an increase in workload at least corresponding to the increasing activity of the hospital. Also, during the last two decades, the importance of laboratory procedures increased with the ability to provide an ever-widening scope of tests, accurate results, shorter response times and decreased costs per tests. These factors led hospital laboratories to an expansion phase that saw even small hsopitals having the ability and willingness to provide a wide spectrum of tests, many of which could not be justified in terms of production costs and user demand. There was, essentially, a period of uncoordinated, rapid growth in laboratory services which, in a number of areas, persists as a problem today. Although there has been more coordination, there is still a need for further coordination and rationalization of the laboratory services in British Columbia.

RATIONALIZATION OF THE DELIVERY SYSTEM AND FINANCIAL CONTROL

Although the Hamilton Report of 1949 (11) outlined a provincial hospital plan for British Columbia, local communities were able to bring significant pressure to bear on the provincial government to fund hospitals in their areas. As the Social Credit government of the day had strong rural support and commitment, deviations from the original hospital plan were common. Smaller communities struggled to have their individual health care needs met and received the bulk of monies for hospital development.

By the mid-1960's there was a range of hospitals with different facilities spread across the province lacking any degree of technological rationale. As mentioned above, such an arrangement began to present problems in the coordination of laboratory services, as well as in other shared services. The primary concern was duplication of expensive services and the inability of smaller centres to utilize their facilities efficiently. Of further concern in this regard, was the growing prevalence of private laboratory facilities.(12) There was some question of whether they should be permitted to compete with the hospital laboratories since the hospital laboratories could provide the same services, albeit, possibly less conveniently, and without a profit margin. This question is still unresolved today.

The Metropolitan Hospital Planning Council

The British Columbia Hospital Insurance Services (B.C.H.I.S.) recognized a lack of coordination of hospital development in the late 1950's, particularly in the metropolitan area of the Lower Mainland. During 1959, a large number of development proposals were submitted to the provincial government by lower mainland hospitals. The need for coordination was evidenced by the amount of duplication of facilities and services proposed in these expansion programs.

Using as a foundation for review a report on hospital facilities prepared by the B.C.H.I.S., The British Columbia Hospital Association, a voluntary body, established the Metropolitan Hospital Planning Council which, in turn, established a professional sub-committee. The objectives of the sub-committee were to analyze the existing referral patterns in the Lower Mainland; to review the existing facilities; and to review the long range plans of local hospitals with a view to possible integration and coordination of future developments.(13)

The study recommended the construction of 600 additional beds in the metropolitan area, a university located hospital, a review of pediatric facilities in the area, long term care facilities, rehabilitative services, and emergency roon facilities. It also recommended a review of the trend towards regionalization of hospital facilities and called for better coordination of diagnostic services such as laboratory services.(13) It was also the recommendation of the sub-committee that B.C.H.I.S. consider implementing a province-wide outpatient diagnostic program.

Such were the beginning efforts to coordinate the planning and development of hospital facilities within geographic regions. The call for a province-wide outpatient diagnostic program has never been satisfied in any coordinated sense, however, a certain pattern of outpatient services, including that for laboratories, has evoloved in B.C. hospitals since the introduction of the B.C. Medical Plan in 1965.

Regional Hospital Districts

In an effort to rationalize municipal planning and to coordinate development, the provincial government set up 28 Regional Districts in 1966 and charged them, among other functions, with the responsibility of regional planning.(12) The role of the Regional Districts was expanded in 1967 with the introduction of the Regional Hospital Districts Act delegating authority for hospital planning to special committees of the Regional Districts. All new capital development and equipment proposals submitted by the hospitals then had to be considered by these authorities prior to being forwarded to Victoria for approval and funding. Hospitals were still required to seek operating grants directly through the Hospital Review Board in Victoria which set the per diem rates according to a privately guarded formula.

The functions of the Regional Hospital Districts were to include the distribution of funds for the establishment, construction, operation and maintenance of hospitals and hospital facilities. However, no capital expenditures could be authorized without the approval of the Minister of Health which led to the Regional Hospital Districts being used as somewhat of a buffer organization for the provincial government when the regional districts had to refuse hospital requests due to insufficient funding from Victoria. This put the expansion of hospital laboratory facilities under the same constraints as hospital construction in general and effectively influenced the expansion of laboratory services by restricting the expansion of laboratory facilities.

The Regional Districts outside the main urban centres of Vancouver and Victoria had difficulty getting organized due to a lack of staff or professional input. Major developments in hospital construction and renovations had already taken place in these areas before the Regional Districts were established so there was little activity required by the smaller Regional Districts and there was little consequence to their lack of organization for future developments. In some cases, hospitals were modernized or additions were built on existing structures, but the main planning and construction requirements were in the Greater Vancouver Regional Hospital District which had never had the level of government investment that had gone into rural areas in the sixties.

In 1969, the Greater Vancouver Regional Hospital District released its regional hospital plan that included recommendations for the building and expansion of hospital facilities in the G.V.R.D. and the priority with which they should be undertaken.(14) The plan had considerable input from the B.C. Medical Association through the Professional Practices Sub- Committee which endorsed the concept of regionalization but stressed the importance of maintaining hospital operating autonomy. Under such a philosophy, hospitals were able to exert pressure individually to have their own plans included in the Districts overall plans.

The fact that the National Health Grants for hospital construction expired in 1971, and that much of the building activity during the sixties occurred outside the Vancouver area had left the greater Vancouver hospitals behind in development. Only the Health Resources Fund remained among federal capital cost sharing programs and it was due to expire in 1980. This fund was established to encourage and assist in the construction of teaching hospitals and was eventually used to build the U.B.C. Acute Care Unit and to upgrade the teaching facilities in the other teaching hospitals in Vancouver. The expiry of the National Health Grants meant the laboratory facilities of many Vancouver area hospitals would remain over-crowded and make-shift for many years to come, placing constraints on the expansion of the services provided by these laboratories. The addition of new facilities at the University of B.C. Acute Care Unit did little to change the situation as that hospital's overall utilization was initially very sluggish leaving the existing and growing demands for services in the other teaching hospitals.

The British Columbia Medical Centre

With the 1971 success of the N.D.P. in forming the provincial government came a change in ideology and policies. The new Minister of Health set up a consortium of teaching hospitals in July of 1973 to be known as the B.C. Medical Centre. The objective of the B.C.M.C. was to "provide advice and assistance in bringing about the orderly development and improvement of facilities and training programs in the health field".(15) In his study on the health security of British Columbians, Foulkes recommended that the member hospitals operate under the direction of a single board representative of the member hospitals but operating outside the jurisdiction of the G.V.R.H.D.(12) He proposed that G.V.R.H.D. representation would be through board membership only.

The respective powers of the B.C.M.C. and the G.V.R.H.D. never were clearly set out or formally established. Whilst the B.C.M.C. did not have any formal or specific authority to plan the development of hospital beds for the Regional District, its existence resulted in power shifts among hospital planners at the B.C.M.C., the G.V.R.H.D. and the local Vancouver hospitals. One of the goals of the B.C.M.C. was to construct a new University teaching hospital on the Oak Street site of Shaughnessy Hospital and streamline the education of B.C.´s health professionals by centralizing their clinical education. Up to that time, the education of health professionals in B.C. was largely based at the Vancouver General Hospital, the University of B.C. and St. Paul´s Hospital. These teaching hospitals obviously felt threatened by the new developments and this period of time was characterized by turbulent power struggles. The development of acute care hospitals was slow and incomplete. The B.C.M.C. was abolished when the Social Credit Party returned to power in 1975 before the Shaughnessy site was ever developed. This was also a period that saw the rapid development of extended care hospitals under the G.V.R.H.D., which now took over that role.

The Bed Matrix

During the provincial election campaign of 1975, the Social Credit Party made several promises related to the balancing of the provincial budget and removing the large deficit incurred by their predecessors. Included in these promises was a plan to abolish the B.C. Medical Centre because it was becoming too grandiose, too expensive and, in their view, unnecessary. In place of the B.C.M.C., the Social Credit Party promised to build a University based teaching hospital and to review the present allocation of hospital beds in the province.

Following their return to power, the Social Credit government quickly abolished the B.C. Medical Centre and the G.V.R.H.D. became the sole capital planning authority. Hospital Programs Division and the G.V.R.H.D. then proceeded to develop a bed matrix plan for Vancouver in 1976. The government of the day wanted to reduce the acute care bed ratio from 5/1000 to 4.5/1000 across the province and 4.25/1000 for urban areas. The government also wanted a five year capital expenditure plan. Other concerns at the time included reduction of the massive size of the Vancouver General Hospital for it had demonstrated its inability to manage itself efficiently. The government had also made election promises to develop new hospitals in Port Moody, on the University of B.C. campus and to redevelop the Shaughnessy site to include maternity, children's and rehabilitation services. It was perceived that to accomplish these goals beds had to be reduced in existing hospitals.

The G.V.R.H.D. was required to develop plans to take into account the above considerations and it responded by preparing a listing of hospitals and available facilities which became known as the bed matrix. The evolution of the matrix was an attempt to rationalize the supply of beds in Vancouver taking into consideration changes in demographics and treatment methods such as ambulatory clinics, and the political constraints imposed by the government. The result was generally a reduction in the bed size of the larger hospitals.

Financial Rationalization

Shortly after the 1968 introduction of the federal Medical Care Act, it became apparent the government could not afford to continue the essentially open-ended payment arrangements negotiated with the provinces.(16) Following much inter-governmental negotiation, the federal government introduced the Established Programs Financing Act (EPF) in 1977 which moved federal funding of health programs from dollar-for-dollar cost sharing to block funding based on a complex formula of per capita funding and changes in gross national product. This move to block funding was to help control the outflow of federal tax dollars and to enable the provinces to fund services that were more responsive to regional needs. Under this agreement, the provinces gained means of obtaining more tax money in addition to a block grant that covered approximately 25% of total program cost but were also charged with more responsibility in containing costs.(17)

Concurrently with these financial negotiations, the Long Range Planning Branch in Ottawa had been trying to re-think the philosophy of health care. To coincide with the changes in the funding of health programs came this new philosophy towards health, encouraged by the federal government and outlined in the Lalonde report.(18) Lalonde urged Canadians to take more responsibility for their health by stressing the importance of lifestyle and environmental factors in current mortality and morbidity. Provincial governments, for their part, had to develop and implement rational approaches to the control of rising health care expenditures.

The Joint Funding Study

In the 1970's, British Columbia's efforts towards controlling the cost of health care included a plan for working toward a more rational method of determining hospital funding procedures. In the early 1970's, the B.C. Ministry of Health budget approached 30% of the total provincial budget and hospitals accounted for approximately 85% of that budget.(17) The hospital's operating budgets were set by the Health Ministry's Rate Review Board through a formula never disclosed to the hospitals. The budget was essentially based on historical patterns and amounted to little more than a simple percentage increase over the previous budget(12). Most hospitals had budget overruns annually and negotiated separately with Victoria for the necessary additional funds. The smaller hospitals usually worked through the B.C. Hospital Association to bring additional pressure to bear on government to pick up the overruns but often found themselves in competition with the larger hospitals which always negotiated separately when it suited their purposes.

With the added pressure from the 1977 EPF Act for provincial governments to control their funding policies, the new Bennett government strengthened the role of the Treasury Board, encouraging it to bring in better control techniques. Pressures were brought to bear on the Ministry of Health to change the method of funding hospitals from a per diem expenditure to a program basis, matching the philosophy of the federal EPF Act, and to end deficit funding by introducing zero based budgeting. In a Financial Discussion Paper, the government also raised questions of the accountability of hospital boards and proposed to designate hospital as public bodies in order to be able to tighten controls. At this point in time, the hospitals refused to agree with the proposal.

In May of 1978, Dr. Chapin Key, then Deputy Minister of Health and former Executive Director of Vancouver General Hospital and President of the B.C. Hospital Association, announced that a Joint Funding Study of B.C. hospitals would be undertaken by a Joint Steering Committee composed of representatives from the B.C.H.A., the Ministry of Health, and the Treasury Board.(17) The actual study involved using the services of the management consultant firm of Ernst and Whinney. The objective of the project was to develop a funding system which would ensure a more equitable distribution of available funds to public hospitals. The tasks included the development of a uniform reporting system, the development of an improved budgeting system and the establishment of a provincial data base.

It was recognized that the existing deficit budgeting system was retrospective in that the budget applications and adjustments took place after the service had been provided. That is, the system essentially permitted, and perhaps encouraged, deficit budgeting. It was also soon recognized by the Joint Steering Committee that an effective cost management system required a categorization of hospitals and their services. Consequently, the Ministry of Health initiated the Hospital Role Study which was to provide the model for a rational framework to guide hospital development and resource allocation over the next fifteen years.(17)

The Hospital Role Study

The Hospital Role Study was a preliminary attempt at defining categories of hospitals according to their functions. The Role Study recognized that, although all hospitals share a common goal in providing health care services, limited resources in health care require that hospitals move towards "realigning their objectives in relation to other hospitals and to other health services in the community".(19) It was believed that changing the relationships between the various components of the health care system would bring improvements in efficiency in the delivery system.

It was stated that the existing hospital system developed out of "societal demands, methods of financing, the organization and distribution of medical practice, and population concentrations".(19) Ideally,, the role of hospitals should be "formulated on the basis of patterns of disease, population and alternative methods of care".(19)

The process of identifying hospital roles was felt to be the first step in addressing a number of problems related to the development and operation of an efficient and effective hospital system. There was a recognized need for a plan to guide future developments within the hospital system, a more appropriate funding mechanism for hospital services, an appropriate distribution of hospital workloads, the appropriate use and distribution of medical technology and a plan for delivering levels of provision for new and expensive health care technologies.(19) The essential part of the study required that the basis for identifying hospital roles had to be clearly understood and accepted by government, hospitals, and professional and consumer bodies.

A matrix of care functions and service levels was developed. There were seven care functions including obstetrics, pediatrics, dentistry, medicine, rehabilitation, surgery, and psychiatry. There were six levels of care including three levels of community services, two levels of referral services, and one level of provincial referral service. With this matrix, a profile of any hospital could be identified as a combination of various care functions provided at various levels of service.

The obvious implication of such a plan, and the most difficult aspect of its implementation, was that each hospital would be pigeon-holed into a specific category based on a province-wide assessment of needs. It was apparent that some hospitals would be targeted for expansion or up-grading while others would remain static or be down-graded with respect to service activity to fit their assigned role. Naturally, all hospitals wanted to be up-graded and it became obvious to the Ministry that such a plan would be, politically, extremely difficult to implement. The plan was, in fact, eventually shelved.

While the Hospital Role Study focused on long term stategies and rationalization, the government of the day was seeking short term cost control. The Socreds renewed their mandate for fiscal responsibility by winning the election of 1979, campaigning on a platform of restraint. The pressure for more cost control increased and the health care sector was targeted as being in need of being brought under control. This objective became clear with the resignation of Chapin Key in 1981 and the appointment of Peter Bazowski as Deputy Minister of Health under the new Minister of Health, James Neilson. Both Neilson and Bazowski had earned reputations for focusing strongly on financial control while they were in the Consumer and Coporate Affairs Ministry. The Role Study was soon put aside in favour of more urgently needed cost control mechanisms.

The effect of these efforts to reorganize and rationalize the health care delivery system in this province has been to bring attention to areas of duplication and oversupply and the corresponding costs associated with these inefficiencies. The focus has largely been on specific diagnostic and treatment programs such as renal dialysis, burn treatment, and open heart surgery; however, efforts at streamlining the delivery of such services have a similar effect on the laboratory services that support these programs. Laboratories have received significant attention in their own right as the volume of laboratory work per patient is increasing as are the laboratory costs per patient. The Ministry of Health is now searching for means to improve the efficiency of the province's laboratory services and to reduce the overall cost of this service.

CHAPTER IV

IMPLICATIONS FOR LABORATORIES

The focus of medical care towards hospitalization, encouraged by the fragmented approach to health insurance experienced in B.C., had significant impact on hospital laboratories. As hospital activity increased, so did laboratory test requests. In addition, as the number of small hospitals increased, so did the number of small laboratories. Laboratories generally tried to provide as full a range of laboratory procedures as possible, sometimes offering procedures which could not be provided cost effectively because they were not frequently used. Such tests would previously have been referred to a larger laboratory. The duplication of laboratory procedures became a prime concern of the provincial government.

This development of laboratory services led to the establishment of regional laboratory facilities during the late 1950's and early 1960's. The Laboratory Advisory Council of the provincial Health Department emphasized the need for regional laboratory services in 1955 and by 1960 had guided the establishment of four regional laboratories providing a regional pathologist and a regional technologist in each of New Westminster, Trail, Kamloops, and Kelowna. The objectives of the regional laboratories included the provision of technical advice to smaller hospital laboratories; the provision of tests not requested every day in smaller hospitals and that were, hence, uneconomical to provide in such hospitals; and the provision of tissue pathology and autopsy services.(12) It was hoped that the development of such regional laboratories would encourage the in-migration of more certified consultants and provide local physicians with the ablity to investigate a patient completely in the local areas and to do it as cost-effectively as possible. These initial steps towards regionalization of laboratory services continued for some years and are still in place in many locations today.

Attempts to rationalize the laboratory services of the province followed the pattern established by similar efforts to rationalize hospitals. Following regionalization came the question of laboratory roles. This issue was addressed in the Hospital Role Study where it was anticipated that the level of laboratory services provided in a hospital would only match the level required by the matrix of care functions provided in that hospital.

Since the Hospital Role Study was never implemented, hospitals continued to be in a position to define their own level of laboratory services. The government's only controlling mechanism was through budget restrictions prohibitive to the uncontrolled expansion of laboratory services. Through this mechanism, the government has forced hospitals to develop more efficient and cost-effective methods of operation. One of the outcomes of these efforts has been the development of inter-hospital referral patterns. Many hospitals have developed their own referral patterns for distributing specimens to laboratories already set up to provide the particular test desired. One of the problems with this approach was that the hospital budgets were very much the subject of political interventions so that the system has not tightened as much as it might have in some areas and, perhaps, overtightened in other areas.

Another problem with this approach is that hospitals began charging each other the outpatient Medical Services Plan rate for inpatient laboratory services. The hospitals felt the charge was necessary to reimburse their operating expenses in providing such service to other hospitals, however, the Ministry of Health felt it was funding laboratories adequately on the basis of total workload units regrdless of where that workload came from. This issue remains unresolved today as interhospital billing continues and the necessary bureaucracy to manage this function continues.

Further implications of the rationalization of hospital funding involves bringing a closer focus on the necessity of many laboratory tests in certain clinical circumstances. It has long been acknowledged that physicians use laboratory services differently but not all general practitioners actually understand the merits and limitations of certain procedures. The provincial government is encouraging B.C. laboratory physicians to assist their peers in proper test selection. Some laboratory physicians feel they should take a very active role in interpreting the necessity of certain laboratory tests while others feel a more passive role is appropriate.(20,21) Through this mechanism of intervention the Ministry of Health hopes to reduce the volume of laboratory test per patient.

Another area of interest with regard to reducing the cost of laboratory services in this province is the role of the private sector in the provision of laboratory services. The private sector laboratories, controlled largely by two major companies, have been particularly successful in negotiating a fee schedule which permits a substantial profit.(12,22) Foulkes showed how the fee schedule, designed around largely non-automated methodologies, became unresponsive to improvements in automation and the corresponding reductions in the cost of tests.(12) He felt the private laboratories were unfairly taking advantage of an outdated fee structure and recommended a review of the province's clinical laboratory test pricing policies. A total review of this policy has never taken place, although recent moves by Medical Services Plan to reject payment for certain test profiles under certain conditions, suggests that efforts are continuing to control the cost of laboratory services through financial restrictions.

Most hospitals now have active outpatient departments and provide laboratory services for ambulatory patients as evidenced by the growing laboratory workload for outpatients in B.C. hospital laboratories as discussed in Chapter VIII. There are those who believe public sector hospital laboratories can assume a more active role in the provision of laboratory services to outpatients at the expense of the private sector clientele. In fact, one of the recommendations of the Foulkes Report (1973) was that the government should move to eliminate private laboratories from the provincial health care delivery system. Such suggestions are still circulating today and the government has difficulty reconciling this conflict between its support of the free entrepeneurial system and its desire to reduce costs in health care.

CHAPTER V

GROWTH IN THE DEMAND FOR HEALTH CARE SERVICES

Victor Fuchs cites several issues related to the demand for health care services and notes that the demand for health care services is one of those few areas of an economy that is relatively inelastic with respect to price.(23) That is, a rise in the price of health care services relative to other prices will not necessarily result in an equal decline in the quantity of health care services demanded. The result will be an increase in health care expenditures at the expense of some other sector of the economy.(23)

Among the factors having the most significant impact on the demand for health care services are rising incomes along with increased public expectations with respect to availability of services, changing population demographics, supply of physicians, and the ability to provide more.

It is generally recognized that the demand for health care services increases proportionately with income. The average Canadian per capita income increased from $2,303 in 1966 to $11,520 in 1981 representing an increase of 400%.(24) In terms of inflation adjusted 1971 dollars, the increase was 76% from $2,758 in 1966 to

$4,863 in 1981. The average British Columbia per capita income for the same period was $2,570 and $12,538 respectively representing an increase of 388%.(24) In inflation adjusted 1971 dollars, this increase was actually 72% from $3,078 in 1966 to $5,293 in 1981.

Population changes clearly have an impact on health care services whether it be merely from increasing numbers or from changing age distributions of that population. It is generally accepted that a small proportion of the elderly use far more health care services than younger and healthier sectors of the population. In addition to increasing numbers, Canada's population is also aging. It is estimated that by 1996 there will be 3.2 million Canadians over the age of 65 compared to about 2 million in 1976.(25) The percentage of people over 65 during the late 1970's was only 8.6% of the total population yet this group accounted for more than one-third of the total annual patient days.(25)

The supply of physicians is considered by some to be the single most important factor governing the demand for health care services.(26) While it is generally the consumer who initiates the first visit for medical treatment, it is the physician who suggests hospitalization, prescribes drugs, orders laboratory tests and x-ray examinations, calls in consultants and who requests repeat visits.(27) In addition to being the chief supplier of medical care, the physician also serves as the patient's chief advisor on how much medical care he needs. Figures presented later in this study will show that the number of physicians have increased at a faster rate than the general population. The numbers, locations, and implications of this trend will be discussed in more detail at that time.

Changing technology and increased automation are also believed to contribute to increased demand for health care services. These factors are responsible for the introduction of new diagnostic techniques and for allowing a faster processing of diagnostic tests making them more desirable to the clinician. As will be discussed later, just providing the ability to do a test quickly and accurately appears to have a significant impact on increasing demand for laboratory services, particularly in the smaller hospitals.

Improved access to medical care for all sectors of the population through hospital insurance and medical insurance has contributed to increased demand for health services. As will be discussed in detail later in this study, this increased demand and the technological ability to provide ever-increasing quantities and improved qualities of diagnostic services has resulted in a surge in the volume of laboratory procedures performed in this province in the last twenty years. This increase in laboratory activity has helped bring attention to this sector of the health care budget as a possible site for gaining improvements in efficiency.

CHANGES IN DEMOGRAPHICS - B.C. AND CANADA

As mentioned previously, one of the most significant factors influencing the growing demand for medical services is the increasing population. The population of British Columbia increased from 1,874,000 in 1966 to 2,640,000 in 1980 which represents a total increase of 40.9%.(28) Up to 1975, British Columbia experienced a much faster rate of growth than any other province. From 1975 onward, the oil boom in Alberta attracted most of the moving Canadian population there. British Columbia's growth in population is primarily due to migration from other provinces, with this form of population growth outnumbering natural increases in the order of 2.5 to 1.(29)

In addition to the increasing number of people, the age distribution of the population will also influence the demand for medical services. It is widely acknowledged that a small proportion of the elderly use a disproportionately large proportion of health services and it is readily apparent that Canada's population is aging. The percentage of the population over the age of 65 has been increasing steadily from 5.1% in 1901 to 7.8% in 1970.(30) By 1981, the percentage of the Canadian population over the age of 65 was estimated at 9.5%.(31) Population projections place the percentage over 65 by 1996 between 11.0% and 11.8% depending on various scenarios of net migration.(32) For British Columbia, the percentage of population over the age of 65 was 9.8% in 1976 and 10.9% in 1981.(33)

Major contributing factors to this trend are a slowing in the rate of immigration, a decline in the birth rate, and a decline in the death rate, all of which result in a much slower natural rate of increase in the population. The birth rate has declined from a high of 28.9 live births per 1,000 population during the peak of the post war baby boom to a low of 15.1 live births per 1,000 population by 1980.(34) During the same period, the death rate per 1,000 population decreased from 9.4 to 7.1.(34) The life expectancy at birth in Canada increased from 60.0 for males and 62.1 for females in 1931 to 70.2 for males and 77.5 for females by 1976.(35) This represents increases of 10.2 years and 15.4 years for males and females respectively. During the same period, life expectancy at 60 increased by 0.9 to 17.2 years for males and by 4.8 years to 22.0 years for females.

Such trends in population have had, and will continue to have, a major impact on the demand for, and delivery of health care. The aging of the Canadian population brings the degenerative diseases of aging into prominance. This requires more emphasis on long term care of the chronically ill and, among other things, pharmaceutical intervention and organ transplants to control the effects of organ degeneration. The effect on laboratories of such changes will likely be to increase workloads due primarily to increases in tests of a screening and monitoring nature. Drug monitoring is already receiving considerable attention in today's laboratories and is talked of as the coming trend of the future.

The effect of these changes in population are reflected in changes in the mix of institutional beds and in the utilization of acute care beds. These subjects will now be discussed in more detail.

CHANGES IN THE MIX OF INSTITUTIONAL BEDS

A review of the changing number and mix of institutional beds coincides with changes in the Canadian population and the health care demands of that population. The number of acute short-term beds increased from 91,965 in 1958 to 106,694 in 1978, representing an increase of 16%.(36) During the same period, extended or chronic care beds increased from 14,337 to 34,211, which represents an increase of 139%.(36) Viewed in terms of beds per 1,000 population, the number of acute care beds decreased from 5.3 to 4.5 while the number of extended care beds increased from 0.8 to 1.5.(36)

Similarly, it was found that the total number of institutional beds per 1,000 population in British Columbia from 1962 to 1978 increased from 15.2 to 17.6.(36) During that same period, the number of acute care beds per 1,000 population decreased from 6.1 to 4.3 and extended or chronic care beds increased from 0.4 per 1,000 population in 1962 to 2.2 in 1978.(36) Such figures clearly show a growing emphasis on facilities for care of the aged.

BRITISH COLUMBIA HOSPITAL ACTIVITY PROFILES

In order to identify changes in the activity of B.C. hospitals over the study period of 1966-1980, several parameters related to hospital activity were examined. These parameters include the number and distribution of beds, the number of patient days and the number of acute care admissions.

In all cases, the number of beds includes all those staffed and in operation as reported on the HS-1 return excluding rehabilition, extended care, other long term care and newborn bassinets. These beds were excluded from review because they typically have very little impact on laboratory activity. The reported categories include medical, surgical, undistributed medical and surgical, intensive care, obstetrical, pediatric, psychiatric and other short term categories not specified above. A short stay bed is more commonly referred to as an acute care bed.

Definitions

An Acute Care Admission is defined as the official acceptance into a hospital of a patient requiring medical and hospital services including room and board in one of the short-stay hospital services described above.(1)

The count of Acute Care Admissions Per Year includes all those acute care patients who were assigned a hospital bed commencing from 12:01 A.M. on the first day of the reporting year.(1)

A Patient Day is the period of service to an inpatient between the census-taking hours on two successive days. The day of admission is counted as a patient day but the day of separation is not. All patient days in this study are based on stay in acute care beds only as defined above.(1)

Bed Distribution

Appendix 1 shows the distribution of the various bed categories as an absolute number and as a percentage of the total number of acute care beds for the year of interest. It should be noted that smaller hospitals frequently provide data that has not, or cannot be, readily categorized according to the requirements of the HS-1 Return due to the multiple function of beds in smaller institutions.

As Table 1-6 of Appendix 1 indicates, there has been an increase of 1,225 acute care beds in all B.C. hospitals over the study period 1966-1980. This amounts to an increase of 11.6%. The largest increases occurred in Intensive Care beds and Psychiatric beds. Intensive Care beds increased from 26 beds in 1970 to 415 beds in 1980 representing an increase of 1496%. Psychiatric beds increased from 192 beds in 1970 to 680 beds in 1980 for a increase of 254%. Steady decreases occurred in the categories of Obstetrical and Pediatric beds with a drop from 1,190 beds to 998 beds for a 16% decrease in Obstrical beds and a drop from 1,600 to 1,252 for a 22% decrease in Pediatric beds.

When the data from each size group is examined it is apparent that the only consistent trend is the ever increasing number of Intensive Care and Psychiatric beds in each size group. Contrary to the general trend, Group IV hospitals increased in Obstetrical beds by 54% and in Pediatric beds by 40%. This may be a reflection of the move towards centralized services as the Group IV hospitals are mostly regional referral hospitals.

It is difficult to suggest any consistent differences in bed distribution between each size group with the possible exception of total medical and surgical beds. This category of bed appears to be consistently more prominent in the larger hospitals of Group IV and V accounting for an average 72% and 78% of the total beds in those groups respectively. In the smaller hospital of Groups II and III, these categories of beds account for an average 66% and 65% of total beds respectively.

Differences in the distribution of hospital beds may be representative of the changing population demographics in B.C. as well as changes in the funding of hospitals which now encourage the use of alternative treatment methods such as ambulatory care and use of extended care facilities. Assuming the differences in the distribution of hospital beds is based largely on rational analysis of need, one could conclude that the decrease in beds in smaller institutions and the increase in beds in the larger ones is a reflection of the move towards urbanization in B.C. and the regionalization of medical services.

Patient Days

Table I shows the total number of patient days for each hospital size group for the study period from 1966-1980. It also shows the percentage change since the previous reporting period. As is readily evident, there was a net increase of 22.8% in the total number of patient days recorded between 1966 and 1980. All hospital size groups exhibit net increases in patient days for the same period ranging from 0.5% for teaching hospitals to 63.7% for hospitals between 200 and 299 beds. There does not appear to be any consistent trend in the number of patient days for each size group with perhaps one possible exception. Following generally large increases in patient days between 1966 and 1970, all size groups experienced decreases, or at least smaller increases, in the number of patient days in subsequent years.

TABLE I
Total Patient Days in Acute Care Beds and Percent Change from Previous Period for all B.C. Public Hospitals by Size Group
1966 - 1980

Hospital Size Group	1966 PD x1000	1970 PD x1000	1970 % C	1974 PD x1000	1974 % C	1978 PD x1000	1978 % C	1980 PD x1000	1980 % C	1966-1980 %
Group I	469	729	55.5	624	-14.5	552	-11.5	559	1.3	+19.2
Group II	635	734	15.6	697	-5.0	724	3.8	801	10.6	+26.1
Group III	219	386	75.8	472	22.5	416	-11.9	359	-13.7	+63.7
Group IV	768	869	13.2	849	-2.3	985	16.0	1008	2.3	+31.2
Group V	706	722	2.3	755	4.6	758	0.4	710	-6.4	+0.5
TOTAL	2797	3440	23.0	3398	-1.2	3435	1.1	3436	0.0	+22.8

PD = Patient Days
% = Percent change from previous year.

Admissions To Acute Care Beds

Table II shows the number of admissions per year to acute care beds for each hospital size group throughout the study period. The percentage change between each reporting period is also presented. Overall, there was a net increase of 13.5% in acute care admissions between 1966 and 1980 for all B.C. hospitals. All hospital size groups show net increases in acute care admissions with the exception of Group I. The increases range from 16.7% for Group II to 77.6% for Group III hospitals. Group I had a 12.1% decrease in acute care admissions. As for Patient Days, there does not appear to be any consistent trend in the number of acute care admissions in each hospital size group.

TABLE II
Total Admissions to Acute Care Beds and Percent Change From Previous Period for all B.C. Public Hospitals by Size Group (1)
1966 - 1980

Hospital Size Group	1966 ACA x1000	1970 ACA x1000	1970 % C	1974 ACA x1000	1974 % C	1978 ACA x1000	1978 % C	1980 ACA x1000	1980 % C	1966-1980 %
Group I	108	99	-8.4	92	-7.1	88	-3.5	95	7.1	-12.1
Group II	78	87	11.7	92	6.2	91	-1.4	91	-0.2	+16.7
Group III	26	49	88.7	59	20.3	38	-35.1	46	20.6	+77.6
Group IV	66	80	22.7	95	18.4	77	-19.3	794	3.5	+21.3
Group V	60	71	16.8	78	10.6	52	-32.7	72	36.9	+19.0
TOTAL	337	385	14.3	416	7.9	347	-16.6	383	10.4	+13.5

ACA = Acute Care Admissions per acute care bed
% = Percentage change from previous period.
(1) The count of acute care admissions includes those in hospital at the beginning of each reporting year.

It should be noted that the above figures on the number of beds, patient days, and acute care admissions only represent the level of activity in each hospital size group. Each hospital size group changed in size and member hospitals between reporting years as individual hospital bed complements changed. The number of hospitals in each size group for each year is listed in Appendix 9.

To obtain a more accurate impression of what has been happening in the various size groups it is necessary to relate hospital activity to the availability of hospital facilities which is accomplished by calculating the number of patient days per bed and the number of acute care admissions per bed.

Patient Days Per Acute Care Bed

The calculation of Patient Days Per Bed is a common measure of hospital activity and is indicative of the hospital's occupancy level or workload. Table III shows the number of patient days per acute care bed for each hospital size group and each reporting year. The percentage change between each reporting year is also indicated. There was an overall increase in patient days per bed of 10.1% for all hospitals. Three hospital size groups demonstrated increases in occupancy ranging from 4.3% for Group III hosptials to 51% for Group I hospitals. The teaching hospitals had a net decrease in occupancy of approximately 11% and Group II hospitals remained unchanged after 15 years. The uncharacteristically large increase in patient days per acute care bed in Group I from 1966 to 1970 raises the possibility that one of those two figures may be in error or the result of different interpretations of the definition for patient days. The aggregation of the data did not allow for this question to be resolved for the reporting hospitals. The increase between 1966 and 1980 for Group I hospitals must therefore be interpreted cautiously.

As might have been anticipated, occupancy levels generally increased with the reduction in available acute care beds. It could be concluded that, overall, the reduction in acute care beds per thousand population has kept pace with decreasing user demand and the increasing availability of alternative care modes. It could also, of course, be argued that the decreasing demand may be the result of the decreased availability. This could easily be so if the number of patient days per bed approached the theoretical maximum of 365. However, the average was 290 patient days per bed in 1980, down from 300 in 1970, suggesting that, overall, an adequate supply of acute care beds is available.

The highest average rate of patient days per bed is found in the Group V hospitals with a study period average of 316.5 days per bed. This is followed by Group III hospitals at 315.3 patient days per bed and Group IV hospitals at 310 days per bed. Group II had an average of 293.2 days per bed and Group I hospitals had an average of 241.3 patient days per bed, if the 1966 entry is not included. The latter is excluded because it does not reflect the average pattern seen over the study period and may be a reporting error.

In terms of the actual number of patient days per acute care bed for individual hospital size groups and trends over the study period, it will be noted that Group I hospitals have consistently reported the lowest use of available beds and that this utilization rate has steadily decreased from 1966 to 1980. Interestingly, the teaching hospitals have gone from having the highest bed utilization rate in 1966 to having the second lowest in 1980. This is likely due to the introduction and application of new treatment methods shortening the length of stay and to various restraint measures to promote more efficient use of available acute care beds such as through the transfer of many services to ambulatory care and alternative institutional care. The result is that the teaching hospitals have become not only the centres for management of the most difficult and complex acute care cases, but the ones making the greatest use of ambulatory care modes.

TABLE III
Patient Days per Acute Care Bed and Percent Change from Previous Period for all B.C. Public Hospitals by Size Group
1966 - 1980

Hospital Size Group	1966 Pt. Day	1970		1974		1978		1980		1966-1980 %
		Pt.Day	%	Pt.Day	%	Pt.Day	%	Pt.Day	%	
Group I	148.4	266.8	79.8	243.2	-8.8	231.1	-5.0	224.1	-3.0	+51.0
Group II	299.9	293.6	-2.1	284.1	-3.2	288.9	1.7	299.9	3.8	0.0
Group III	302.9	305.5	0.9	313.3	2.6	324.0	3.4	331.0	2.2	+9.3
Group IV	305.1	309.4	1.4	304.0	-1.7	313.6	3.2	318.1	1.4	+4.3
Group V	331.5	336.1	1.4	288.9	-14.0	330.7	14.5	295.3	-10.7	-10.9
TOTAL	264.0	300.4	13.8	284.7	-5.2	295.8	3.9	290.7	-1.7	+10.1

Pt. Day = Patient days per acute care bed
% = percentage change from previous period.

It is also interesting to note that Group III hospitals have the highest bed utilization rate and that it has continually increased from 303 patient days per bed in 1966 to 331 in 1980. Hospitals in this category are between 200 and 299 acute care beds and are typically located in the larger centres outside the Vancouver and Victoria area. Their increased utilization may be an indication of the increased urbanization of the B.C. population and/or regionalization of services also reflected in the drop in patient days in hospitals of less than 100 acute care beds.

Admissions Per Acute Care Bed

The calculation of the number of admissions per bed is another common hospital activity indicator and is indicative of the turnover of patients. It may also be considered indicative of the acuity or severity of illness of the patient population and/or a reflection of the standard of practice for a particular medical community. It is not a measure of the length of stay as defined in the HS-1 returns, but is indicative of that measure.

Table IV shows the number of acute care admissions per acute care bed and the percent change between reporting periods for each hospital size group. Overall, there was only a modest net increase of 1.9% in the number of acute care admissions per bed. Group III hospitals experienced the largest net increase in acute care admissions per bed at 18.4% followed by Group I hospitals at 9.5% and Group V hospitals at 5.3%. Group II and Group IV had modest net decreases of 7.3% and 3.5% respectively.

The highest average number of acute care admissions occurred in Group III hospitals with an average 37.1 acute care admissions per bed. This is followed by Group I hospitals and Group II hospital with 36.3 and 35.9 acute care admissions per bed respectively when averaged over the study period. Teaching hospitals and hospitals of 300 or more beds had the lowest average acute care admissions per bed with 28.8 and 27.7 respectively. This difference in acute care admissions per bed between hospital size groups may be a reflection of varying patterns of practice and varying acuity of patients seen in each category of hospital with teaching hospitals and regional referral hospitals probably having the most acutely ill patients requiring the most intensive and lengthy care.

When data for individual hospital size groups are examined from one reporting period to the next, it is apparent that once again there are no consistent trends emerging.

TABLE IV
Acute Care Admissions per Acute Care Bed and Percent Change from Previous Period for all B.C. Public Hospitals by Size Group
1966 -1980

Hospital Size Group	1966	1970		1974		1978		1980		1966-1980
	ACA	ACA	%	ACA	%	ACA	%	ACA	%	%
Group I	34.6	36.1	4.3	35.7	-1.1	37.0	3.6	37.9	2.4	+9.5
Group II	36.8	34.8	-5.4	37.6	8.0	36.4	-3.2	34.1	-6.3	-7.3
Group III	35.8	38.7	8.1	39.0	0.8	29.7	-23.8	42.4	42.8	+18.4
Group IV	26.0	28.6	10.0	34.1	19.2	24.5	-28.2	25.1	2.4	-3.5
Group V	28.4	32.8	15.5	29.9	-8.8	22.9	-23.4	25.1	30.6	+5.3
TOTAL	31.8	33.7	6.0	34.9	3.6	29.9	-14.3	32.4	8.4	+1.9

ACA = Acute Care Admissions per bed
% = percentage change from previous period.

Average Length of Stay

Data regarding the actual average length of stay were not collected. This average is calculated from the number of patient days generated by patients separated in the reporting year from the date of admission, regardless of when the admission occurred. An approximation of this figure may be calculated from the number of patient days per acute care admissions although it will not include the number of patient days prior to the reporting year attributable to patients remaining in hospitals during the reporting year.

This calculation is presented in Table V. It is readily apparent that the average length of stay is less in the smaller hospitals than the large hospitals, ranging from an average of 6.1 days in Group I hospitals to an average 11.4 days in Group IV hospitals. It is difficult to identify any consistent trends between reporting periods throughout the study although it may be argued that the length of stay is decreasing in Group I hospitals and Group V hospitals, increasing in Group IV hospitals, and remaining relatively constant in Groups II and III.

Contrary to what may have been expected based on situations reported in the literature, the length of stay in the teaching hospitals in B.C. is not any longer than that of non-teaching hospitals and, in fact, in 1980 was considerably less than in the large hospitals of Group IV. This is probably a combined result of increased medical and surgical services offered by the large regional hospitals of Group IV and the result of restraint efforts in the teaching hospitals.

TABLE V
Patient Days Per Acute Care Admission and Percent Change From Previous Period for all B.C. Public Hospitals by Size Group
1966 - 1980

Hospital Size Group	1966 Pt. Day	1970		1974		1978		1980		1966-1980
		Pt.Day	%	Pt.Day	%	Pt.Day	%	Pt.Day	%	%
Group I	4.3	7.4	72.1	6.8	-8.1	6.2	-8.8	5.9	-4.8	+37.2
Group II	8.1	8.4	3.7	7.6	-9.5	7.9	3.9	8.8	11.4	+4.7
Group III	8.5	7.9	-7.1	8.0	1.3	10.9	36.3	7.8	-28.4	-1.2
Group IV	11.7	10.8	-7.6	8.9	-17.9	12.8	43.8	12.7	-0.8	-15.3
Group V	11.7	10.2	-12.8	9.7	-4.9	14.4	48.5	9.9	-31.3	-15.3
TOTAL	8.3	8.9	7.2	8.2	-7.8	9.9	20.7	9.0	-9.1	+8.4

Pt.Day = Patient days per acute care admission
% = percentage change from previous period.

PHYSICIANS AND ISSUES RELATED TO THEIR ROLE IN LABORATORY UTILIZATION

As mentioned previously, physicians constitute the single most important element of the supply side of health care services. However, they also constitute a very important element of the demand side of these services. This would appear to provide an environment for considerable conflict of interest. Nevertheless, as Fuchs points out, a physician's actions are generally not motivated by profit potential, but instead by what Fuchs refers to as a "technologic imperative".(23) That is, medical education traditionally emphasizes giving the best care that is technically possible. The only explicitly recognized constraint in the eyes of the physician is the state of the art. This pattern is reinforced by the public willingness to support new medical technologies and their desire that it be available to them. This need for physicians to appear up to date, the innate "need to know", as well as concern over the growing number of malpractice suits, encourages physicians to provide "state of the art" medical care. Where there is a third party payment system without sanctions, over-servicing may be encouraged.

The increasing number of physicians in Canada and the increasing specialization of physicians are often identified as being the most important elements in rising health care costs.(26,37) While there is clearly a direct relationship between the number of physicians and the cost of health care, this relationship must be viewed in light of its being demand-induced by a better informed public with more disposable income, and an apparent willingness to support the increased availability of medical services through public channels. (23)

The merits of this public desire to spend more on health care, that is, to make health care services more readily available, are identified in J.M. Last's "clinical iceberg" analogy.(38) The iceberg represents the sum total of all medical needs that can be treated by a physician. The iceberg finds its own equilibrium in water with the bulk of its mass being submerged. The proportion of the iceberg which is above water represents those needs which actually receive the attention of a physician. Most of the diseases seen by physicians in the section above water are preceded by sub-clinical manifestations below the water; that is, manifestations which are not brought to the overt attention of a physician. Last maintains that many acute and chronic diseases may be prevented by early detection of sub-clinical symptoms, by examination and diagnostic testing, followed by an appropriate treatment; that is, by a planned program of preventive health care.

The level at which the iceberg of disease floats in the water is determined by the accessibility to medical care which in turn, is determined by economic barriers, the supply of physicians, and the development of diagnostic technology. Improving accessibility to medical care by removal of economic barriers and increasing the supply of physicians could possibly lead to a reduction in chronic illness and reduced long term intitutional care. The issue then becomes not so much a question of whether increased numbers of physicians will improve the health of the population, but a question of how much health care the public can afford, either through direct payments to care providers or through third party payers.

There are, as yet, still many questions to be answered with regard to the economic and social advantages of increasing physician supply in the hopes of preventing acute and chronic disease or continuing to concentrate on treating such diseases after they have developed. For now, the reality is that physician supply is one of the key driving forces behind escalating health care costs. The more physicians there are, the more patient visits there are, and typically, the more laboratory tests ordered.

The relationship between the supply of physicians and the demand for health care services is particularly evident in relation to the use of laboratory services. Several factors are reported to influence the demand for such services. However, many authors place the supply of physicians as the number one factor in this regard. (39,40,41,42,43)

It has been shown that the use of laboratory tests is increasing at an alarming rate and consuming an increasing proportion of the health care budget.(39) One study has demonstrated that the laboratory's share of the overall hospital budget increased from 7.14% in 1971 to 9.0% in 1976.(40) Health and Welfare Canada reported that during the mid-seventies, laboratory services accounted for over 10% of the total health care dollar.(44)

There are a number of theories put forward to explain why the number of practicing physicians appears to influence so strongly the use of medical services in general and laboratory services specifically. Schroeder, a U.S. physician, suggests that a very strong association exists between the use of diagnostic and therapeutic technologies and physician density, saying that they are directly proportional, at least in a fee-for-service setting.(45) Schroeder feels that the most important factor in the U.S. contributing to the use of medical technology is the pro-technology bias of reimbursement for medical care in hospitals and physicians offices. He suggests that many technical procedures carry a higher valuation of physician time than is necessary, and hence, a higher fee schedule. Assuming this to also be the case in British Columbia's fee-for service sytem, it would provide physicians with a financial incentive to order more procedures in order to increase their incomes.

One study has shown that a physician in the U.S. could increase his income by almost three fold by performing more in-office procedures and ordering more laboratory tests.(46) This financial incentive becomes a factor when one considers the probable targeting of physician incomes by physician expectations for a particular income level irrespective of physician density.(47) That is, every physician entering the field expects to earn a large income to reward his efforts and the time spent in training, and the payment system is designed to permit this. Schroeder cites estimates suggesting the addition of one physician adds approximately $250,000 to the annual operating cost of the health care systems in both Canada and the U.S. He attributes much of this to the use of technologies, including laboratory tests.(48)

Other factors influencing the increased use of laboratory services are utilization review and the practice of defensive medicine. It has been suggested that peer review almost inevitably leads to a greater use of services, particularly in ambulatory care.(49) It has further been suggested that such quality assurance programs as the Professional Standards Review Organizations in the U.S. could perpetuate existing practices rather than examine the necessity of a particular service or practices. Through their organizational design using current practices as the accepted standard, the contribution of PSRO's to the control of the use of medical services is limited and likely even increases the use of some services because it is deemed "good medicine" by review committees.

Similar efforts in Canada to standardize the quality of care, such as hospital quality appraisal committees, may also apply upward pressure on the use of diagnostic support services such as laboratories. It is likely that such committees are able to exert some level of control on physicians who are consistently using diagnostic services at a higher rate than their peers. Nevertheless, they may also raise the base utilization of such services by below average user physicians by virtue of their desire to conform to the norm.

The development of quality appraisal committees is supported, and indeed required, by the Canadian Council for Hosppital Accreditation. Accreditation is not required for hospitals to maintain their operation in B.C. However, since it is desirable to prove to the community and practicing physicians that the facility is a quality operation with the mechanisms in place to provide an acceptable quality of care, all but the smallest hospitals are accreditated. Accreditation organizations also influence the use of diagnostic services by specifying diagnostic approaches to the treatment of certain patients such as pre-surgical laboratory and radiological examinations. One study has shown that when physicians were faced with constraints on their use of laboratory facilites, among the first tests given up as non-essential were routine blood counts and urinalysis required as part of the admission procedure. Although this study was conducted in an artificial environment, it does provide an indication of how the physicians involved viewed the signficance of routine pre-admission tests required by policy rather than by clinical necessity.

Physician fear of possible future litigation must also have a degree of impact on the use of medical technologies although, as yet, there is little evidence to support this view. Comparative evidence of the impact of fear of litigation is provided in a study of the volume of radiological examinations and laboratory tests performed in Swedish hospitals. In this socialized medical system which has a very structured grievance redress system, the volume of such tests was found to be about half the amount ordered on patients in American hospitals.(50)

There may be some conflicting impacts of defensive medicine. Some physicians are becoming more cautious in performing "high risk" procedures or in dealing with patients they regard as being inclined to sue. Other physicians are performing more diagnostic tests than would otherwise be necessary.(51) The effect of defensive medicine is less dramatic in Canada than in the United States although with the new Charter of Rights and Freedoms, there is a growing awareness on the part of the patients of the possibility of redress. It is unlikely that Canada will ever have a crisis similar to that in the U.S. because the American cultural and legal milieu is different and the Canadian health insurance plans discourage suits.(52)

Most physicians in Canada do not carry malpractice insurance but instead, belong to an organization called the Canadian Medical Protective Association. The Association is a mutual non-profit society and there is no guarantee that a physician will be covered if he is sued for malpractice although it is virtually assured. Because it is a non-profit organization, decisions are not made on the basis of the profit motive. In some cases, it may be less expensive to pay than fight. However, C.M.P.A. will defend the case if it believes that its member was right. This attribute of the Association has undoubtedly discouraged many malpractice suits.(53)

The number of legal claims against members of the Canadian Medical Protective Association increased 10% from 1980 to 1981 and 31% from 1979 to 1980.(52) These increases may be softened somewhat by noting that the number of members has also increased although the percentage increase in members is markedly smaller than the increase in law suits. The actual number of actions settled increased modestly in 1981 from 121 to 127 and pre-trial dismissals or discontinuances increased from 156 to 220. Despite this relatively good record, the number of malpractice suits in Canada continues to rise. Knowledge of this must certainly have an effect on a physician's style of practice.

Other factors that have been identified as being associated with how physicians use laboratory services include a physician's personality, the date and place of graduation and the availability of facilities and expert medical and technical suppport personnel.(40,42,54) Hardwick has shown that in an artificial environment, physicians faced with the constraints of limited resources relied more heavily upon the history and physical examination of the patient than on the technical support of modern medical science.(54) The findings were consistent when financial constraints limited the number of laboratory tests that could be ordered and when practicing general physicians were faced with not having sufficient expert medical and technical personnel to accurately perform and interpret laboratory results.

In B.C.'s health care delivery system, the financial constraints of consumers are not a factor in determining a physician's use of laboratory services. The primary financial constraint in B.C. influencing the use of laboratory services is the level of funding granted hospitals to operate their laboratories. By restricting the laboratory's ability to grow in terms of staffing, equipment, and physical plant, the government can effectively limit the growth in the level and quantity of laboratory services offered by laboratories. Until the present economic down-turn in the B.C. economy, there has been little in the way of concerted effort on the part of government to control the use of laboratories in this manner. Wide-spread budget cuts in the health care sector of the last two years have led to staffing reductions in laboratories and limitations of the expansion of capital equipment. This has forced hospitals to consider the merits of some laboratory procedures and to attempt to control the use of laboratory services.

Schroeder found that, in the U.S., patients with similar ailments paid approximately eleven percent more when admitted to a university associated teaching hospital rather than to a general community hospital.(55) Approximately 56% of the difference in costs was directly attributable to the greater use of diagnostic services in the teaching hospitals. The availability of the appropriate facilities and personnel, as well as what Schroeder refers to as the "don't miss anything" attitude of most academic centers, are key contributing factors.

Freeborn studied changes in the utilization of laboratory services in the Kaiser-Portland Health Plan.(42) In addition to finding that economic barriers, as determined by the degree of co-payment, had less impact on laboratory use than was expected, he identified several physician characteristics related to their use of laboratory services.(42) Among his findings was the observation that there was a tendency for older physicians to use laboratory services less than relatively new medical school graduates. This was attributed to what a physician was taught in medical school on how and when to use diagnostic support services. However, other factors such as experience, attitude, and skills may play equally important roles.

Freeborn also found a relationship between the school of graduation and the pattern of laboratory usage. Physicians trained in medical schools in the U.S. northeast, in California and in the Chicago area were more likely to be low volume laboratory users than physicians trained in other areas of the U.S.(42)

There was also found to be a relationship between laboratory use and the utilization pattern of the chief of service in that system. In those clinics where the chief of service had a low laboratory use rate, more than three-fourths of the other physicians were low laboratory users. When the chief of service was a high laboratory user, so were most of the physicians who worked with him.(42)

In addition to finding considerable variation in the use of laboratory services among physicians, Freeborn also found that not only had the total number of procedures increased annually, but the number of procedures per subscriber and the number of procedures per doctor office visit also increased markedly over the study period. Subsequent analysis of this laboratory use over time with respect to client morbidity showed that a substantial part of the increased lab utilization was in the category of non-disease or preventative services.(42)

Similar findings are reported by Daniels and Schroeder.(56) They examined variations in the use of laboratory services among thirteen salaried internists treating a group of ambulatory patients for hypertension. The use of laboratory services was correlated with clinical productivity and clinical outcomes. Their findings of considerable variation in the use of laboratory tests among this group suggests that those physicians who may be less competent tend to use the laboratory more frequently. In addition, their findings did not support a positive association between the degree of laboratory use and either clinical productivity or outcomes of care.

From the above evidence, it is readily apparent that the supply of physicians, their ages, their personal backgrounds, their training experience, and their practice environment, including the presence or absence of financial barriers, have a direct impact on the demand for laboratory tests. This in turn, has a direct impact on the demand for medical laboratory manpower. Such a relationship serves to focus attention upon the issue of specialization and upon trends developing in the supply of laboratory physicians.

THE EFFECT OF TECHNOLOGY AND AUTOMATION IN LABORATORIES

Since the end of the second world war, developments in technology and automation have been occuring at a rate beyond the capability of most people to comprehend and stay abreast. The advent of computer technology and electronic micro-circuitry has led to the creation of more and more automated machines that are "smarter", faster, more compact, and generally less expensive than their predecessors. They have also become increasingly simple to operate bringing their accessibility to a very wide spectrum of potential users.

This is particularly true in laboratory technology. In laboratories, where it was once common to have a single machine to perform a few tests individually under the constant care and handling of a technologist, it is now common to have a single machine performing 10 to 20 tests and more on a single machine. The technologist's role has become one of ensuring the equipment if operating correctly and the correct specimen is being processed. There is no need for most technologists to be concerned with the intricacies of biochemistry in their day to day work.

Machines have been developed for hematology that go beyond the mere counting of blood cells. Cell counters now tell the technologist how many cells are present, the type of cells present, whether or not the cells are normal, and the ratio of one type of cell to another.

It has only been lately that automation has made inroads into microbiology. There are now machines that incubate specimens, determine whether or not there is bacterial growth, and through a series of chemical tests, identify the bacteria and print-out the answer for the technologist.

With such resources now at hand, one would expect them to have a significant impact on the traditional day to day operation of laboratories. Two expected impact areas are laboratory manpower and laboratory costs.

As might be expected, such developments have a substantial impact on a laboratory's ability to meet increasing demands. However, it should be noted that an apparent side effect of increasing automation is that it increases the demand for laboratory services by making laboratory tests more readily available and more economically feasible.

THE EFFECT OF AUTOMATION ON LABORATORY COSTS

Attempts have been made to quantify the relationship between automation and laboratory operating costs.(57,58,59) Tydeman hypothesized that increased automation would result in increased consumables and reagent costs as measured by Total Cost per FTE.(58) The amount of manpower required to perform a test would decrease and the demand for the test would increase due to a greater variety of tests and ease of access to tests. Data derived from Vancouver General Hospital over the study period 1971-1979 demonstrated that while the degree of automation, in terms of dollar value, increased 3.4 fold, the amount of time required to perform tests decreased by an average 2.2% annually.(58) These data also show that while the number of tests per acute care admission increased by 114.4% and the total laboratory cost per acute care admission increased by 106.9%, the operating costs of the laboratory per FTE increased only 34.1% over the 9 year study period.(58) The authors concluded that technology can reduce the real cost of performing laboratory tests or at least stem the tide of cost increases. However, the increase in the availability of laboratory tests appears to induce a latent demand for tests thereby increasing the overall laboratory cost per acute care admission.

SUMMARY

British Columbia's population has increased by approximately 41% between 1966 and 1980. The percentage of British Columbians over the age of 65 increased from 9.8% in 1976 to 10.9% in 1981. During the period 1962 to 1978, the ratio of acute care beds in B.C. decreased from 6.1 beds per 1,000 population to 4.3 beds per 1,000 population while the number of extended care beds increased from 0.4 per 1,000 to 2.2 per 1,000 during the same period.

Changes in the distribution of beds in British Columbia were noted to include overall increases in the number of Intensive Care and Psychiatric beds and overall decreases in the number of Obstetrical and Pediatric beds. Trends in bed distribution were consistent between the various size groups with the exception that there were substantial increases in the number of Obstetrical and Pediatric beds in the hospitals of Group IV. This was attributed to the centralization of these services to regional hospitals.

Patient days per bed increased by a total of 10.1% for all B.C. hospitals, representing a general increase in hospital activity. Hospital activity increased fairly consistently in hospital size groups III and IV and was up and down in the other size groups. Teaching hospitals had the highest activity level while the hospitals of Group I experienced the lowest activity.

The number of admissions per bed is indicative of the length of stay. The shortest lengths of stay were found in the smallest hospitals while the Group IV hospitals had the longest lengths of stay.

Through the various efforts to rationalize and streamline the health care delivery system, we have seen a reduction in the proportion of acute care beds in B.C. hospitals occupied by long term patients. The availability of alternative care modes have been helpful in this regard although, as the current waiting lists for entry into an extended care facility indicate, there is still a shortage of chronic care facilities and an apparently adequate supply of acute care beds, based on current province-wide occupancy levels.

We have also seen that physicians play a very major role in determining the demand for laboratory services and, among physicians, it was noted that their age, place of training, personality, and other behavioural factors all influence how they use laboratory services. Such characteristics of physicians' use of laboratory services have been the subject of several efforts to modify or control their laboratory utilization patterns.

Another major influence on the demand for laboratory services appears to be the degree of automation. Studies have indicated a relationship between the availability of tests and the demand for those tests. One of the effects of automation is to improve the availability of laboratory tests by making them easier to perform, faster to complete, and makes the technology required to do the test widely available.

Implications for Laboratories

The relocation of long term care patients to more appropriate facilities will have an effect on the volume of laboratory procedures per bed or acute care admission as acute care hospitals use more of their beds in the treatment of the acutely ill. This will have significant implications for planners of health care facilities trying to identify an appropriate sized laboratory for a certain sized hospital.

An additional consideration for health care planners is the increasing role hospitals play in providing outpatient services. Diagnostic support services, including laboratories, must be designed, staffed and equipped to meet more than just hospital inpatient demand.

The degenerative diseases of an aging population may also have a further impact on the utilization of hospital beds and laboratory facilities. Drug monitoring, as a means of following the course of pharmaceutical interventions in moderating the process of aging, is becoming increasingly common. As the population continues to age, we may see an increase in the average age of patients in acute care facilities and the volume of laboratory workload per patient day will likely increase due to the monitoring of drug levels.

CHAPTER VI

ISSUES RELATED TO THE SUPPLY OF HEALTH CARE SERVICES

The supply side of health care services is chiefly controlled by the supply of labour and capital flowing into the industry, especially the number of physicians. Retrospectively, the health care industry has, in the past, usually been able to attract an adequate workforce without having to pay inordinately high wages. Only in recent years have the salaries of health care workers approached those of other service industries. In an industry where 80% of the total budget goes to salaries, these gains have had an important role in drawing attention to the high cost of our health care delivery system.

The flow of capital is a little more complicated because it has been influenced primarily by government decisions and philanthropy and rational thought is not always the primary concern of government decisions. As mentioned previously, political patronage played an important role in the development of British Columbia's hospitals. While the government is still the major source of capital funds for hospital construction, the private sector (corporations and individuals) is playing an increasing role in the funding of health care facilities and programs as government funding becomes increasingly tighter.

Technology and automation also play a key role in the supply of health care services. New diagnostic and therapeutic techniques can improve the productivity of the physician visit or hospital stay by producing more and better results and allowing the throughput of more patients per unit of supply.

The Supply of Physicians

The number of physicians plays a key role in the supply of medical care because their decisions and behaviour affect almost all aspects of the delivery of health care services.

Statistics Canada figures show how the number of physicians has increased in Canada from 1968 to 1978.(60) The number of general and family practioners increased by 52% from 11,778 to 17,913. This represents a change from one general practitioner per 1,786 population in 1968 to one general practitioner per 1,316 population in 1978.

During the same period the number of specialists increased by 56.5% from 11,191 in 1968 to 17,519 in 1978. The ratio of specialists to population changed from one to 1,852 in 1968 to one to 1,351 in 1978. If interns and residents are included, the total ratio of physicians to population changed from one to 741 in 1968 to one to 559 in 1978. This represents an increase of 32.6% in the physician to population ratio.

Statistics Canada also provides figures comparing the number of physicians practising in each province in 1978.(60) British Columbia had the highest ratio of general practitioners to population of all provinces with 1,075 people per general practitioner. Quebec has the highest number of specialists per population followed by British Columbia with 1,266 people per specialist. Including interns and residents, Ontario and B.C. both report one physician for every 529 people. If interns and residents are not counted, B.C. has far more physicians per population than any other province with one physician for every 578 people. Ontario and Quebec have the next highest ratio of physicians to population with one to 645 and one to 649 respectively. Both these figures exclude interns and residents. It is clear that interns and residents have a much greater per capita impact on the health care system in Ontario and Quebec. This is likely due primarily to the greater number of funded resident and intern positions in the long established teaching hospitals of these provinces. It is generally recognized that interns and residents often order more lab work than a more experienced physician because of the teaching milieu and the fear of missing a diagnosis as well as just being generally more geared towards and dependent on technology.(60)

The supply of physicians is directly related to enrollment policies of medical schools and to immigration policies. Both of these factors are of considerable political importance. Most provincial governments are under strong pressures to provide the opportunity for the sons and daughters of provincial residents to attend a local medical school. There are generally significant political points to be gained by supporting professional opportunities for the electorate on a local basis. Consequently, most provinces now have at least one medical school providing such opportunities.

To reduce medical school enrollments in these institutions is politically difficult. Canada is, therefore, faced with a situation wherein the long established eastern medical schools continue to turn out increased volumes of graduates while the new "frontier" schools have also actively increased their enrollments.

A case in point is British Columbia's recent activities in this regard. In fulfillment of a 1975 election promise of the Social Credit Party, the Minister of Universities, Science and Technology announced his intention in March 1976 to allow the University of B.C. to double the size of its medical school enrollment from 80 to 160.(61) At that time, British Columbia already had the highest concentration of physicians in Canada. However, the Minister strongly believed that the opportunity of local medical education should be provided to the youth of the province. A downturn in the provincial economy and the recommendation of the Ministry of Health's Medical Manpower Advisory Committee to postpone planned expansion of the medical school has delayed full implementation of the increases.(62) Nevertheless, enrollment has increased from 80 to 120. It is still too early to tell what impact this move will have on the health care industry in B.C. but new graduates are already having to search for available positions.

As already mentioned, Canada's ratio of physicians to population reached one to 559 in 1978; well beyond the goal of one to 600 set by the World Health Organization. However, there are still gross inequities between provinces and between regions within provinces in the distribution of this manpower resource.(60) Typically, urban centres have a much higher concentration of physicians than rural areas, sometimes requiring rural residents to travel a considerable distance to acquire the level of medical services readily available in urban centers. Recently, there have been attempts to control the distribution of physicians which have met with some degree of success.(63)

Ontario has offered grants to assist physicians in establishing their practices in under-serviced areas of the province. Ontario has also experimented with providing guaranteed income levels during the initial years of practice in such under-serviced regions. British Columbia has also offered subsidized income in certain situations. Quebec recently introduced a plan to encouragement better distribution of their medical manpower by adjusting the fee schedule for in favour of rural practices.

British Columbia's new Medical Care Act contains proposals designed to control where and how phyicians practice. One proposed method is to restrict the availability of Medical Services Plan billing numbers issued by the government controlled Medical Services Commission. Without such a number a physician is not eligible to submit bills to MSP that are normally covered as an insured service. The physician would have to charge the patient directly for services provided. By setting limits on the quantity of billing numbers available in each geographic region, the provincial government will be able to control the flow of physician manpower.

As discussed previously, the number of specialists per 100,000 population in Canada increased 56% form 1968 to 1978. During the same period, the number of general and family practitioners increased by 52%. It is reported that during the 1960's the number of general physicians in Canada increased by 19% while the number of specialists increased by 70%.(63)

Some authors have suggested that the output of specialists seems to be linked more to the prestige of the specialty and the momentum of the residency training program than to the need for its products.(63) It is frequently acknowledged that, like the relationship between the number of general practitioners and laboratory utilization, the more specialists there are, the greater the use of laboratory services.(48) Yet, as the volume of laboratory tests has been increasing dramatically in latter years, the number of laboratory physicians completing their Royal College Certification has been relatively constant.(64) It would seem that the workload of each individual laboratory physician is increasing given that other factors have remained relatively unchanged.

As in other specialties, the distribution of laboratory physicians indicates a clear concentration of this specialty in the more densely populated areas of the country. In fact, the urban centres of Montreal and Toronto have over half the country's specialists in Microbiology, Hematology and Immunohematology yet a disproportionately small percentage of the country's general pathologists.(65) In total, these two urban centres with approximately one-fifth of the nation's population have over one-third of the nation's laboratory physicians.

The nationwide distribution of laboratory physicians in 1981 ranged from a low of 2.9 laboratory physicians per 100,000 population in New Brunswick to a high of 7.1 in Quebec. British Columbia has a rate of 4.7 laboratory physicians per 100,000 people which is below the national average of 5.3.(66)

With a relatively low number of specialists in laboratory medicine in B.C. and the extraordinarily high number of general physicians generating laboratory requests, there appears to be the potential for a shortage of laboratory physicians, with other factors being equal. This apparent need for laboratory physicians in B.C. is offset somewhat by considerable sharing of manpower. Many laboratory physicians in B.C. have responsibility for laboratory medicine in more than one hospital and community. This may be reflected in the proportion of general pathologists practicing in B.C. Approximately 45% of all B.C. pathologists are general pathologists compared to 36% in Ontario and 48% in Alberta.

MEDICAL LABORATORY TECHNOLOGISTS

Historically, medical laboratory technologists acquired their skills through on-the-job training in hospital laboratories under the supervision of a pathologist. The first technologists in Canada to be certified had to do so through the American Society of Medical Technologists and this avenue only became available in 1930.(67)

On May 20,1937, the Canadian Society of Laboratory Technologists was incorporated in Ontario. In 1938, the certification examinations were conducted for nine candidates. By 1940, the membership had grown to 200 and in 1980 there were 15,451 active C.S.L.T. members across Canada.(68) The first branch of the C.S.L.T. was founded in Saskatchewan in 1937. The tenth branch to be formed was in Newfoundland in 1962.(67)

The Canadian Medical Association formally recognized the C.S.L.T. as the official registry for medical laboratory technologists in Canada on January 1,1941. The Canadian Hospital Association first recognized the C.S.L.T. as an associate member on July 24,1957. In 1958, the Canadian Medical Association officially recognized the C.S.L.T. as an affiliate society of the C.M.A. and in 1962, the C.M.A. introduced the formal accreditation of medical technologist training programs in conjunction with the C.S.L.T.(69) The federal education grants of the late 1950's and early 1960's led to a rapid increase in the number of community colleges which became involved in the training programs. This resulted in a more formal academic training of technologists through classroom instruction and preserved the hospital intership as the final requirement for registration.

With the move to the community colleges came a stratification of the membership to the point where there are now four levels of training and certification. The Registered Technologist (RT) qualification is the general certification for a graduate of one of the approved programs. It is available either as a "subject" RT with certification in only one discipline or a "general" RT with certification in all laboratory disciplines.

The RT Subject requires completion of courses equivalent to first year university plus one year of clinical laboratory experience in a specified discipline. The available disciplines include Chemistry, Hematology, Blood Bank, Microbiology, Histology, Cytology, and Virology. Upon completion of the above requirements, the RT Subject candidate must also successfully complete the C.S.L.T. certificate examination in the subject area.

The RT General requires completion of an approved laboratory technology program, usually of 18 months to 24 months duration, and one year of clinical laboratory experience covering the five subject areas of Chemistry, Hematology, Blood Bank, Microbiology, and Histology. Following the clinical training the candidate must then successfully complete the C.S.L.T. certificate examination in all subject areas covered.

The Advanced Registered Technologist certification (ART) is available following a minimum of two years experience as an RT and requires the satisfactory completion of a literature review and technical report or oral examination. The advanced registration is available as either an ART Subject or ART General.

The Licentiate certification is based on work experience and requires the successful completion of a literature review, a thesis in a particular subject area, and an oral examination.

The fourth and highest level of certification is the Fellowship. It is reserved for senior members of the profession who have made outstanding contributions in the field. It is awarded following nomination and peer review.

Recently, a new level of qualification for medical laboratory technologists has developed at the university level. Several universities are now offering Bachelor degrees in Medical Laboratory Science. Such programs are generally designed to produce graduates who are theoretically sound, practical scientists in laboratory medicine. It is considered that graduates of these programs will find roles in routine medical laboratories, in supervisory positions, in research and development, and in teaching. As most of these programs are quite new, it is not yet possible to measure their success in placement of their graduates. Nor is it possible to measure the impact on enrollment in Registered Technologist programs, or on the placement and upward mobility of the graduates of such programs. It is likely that, to date, the impact of the degree programs on the placement of RT's has been minimal although there may well be increased competition for senior laboratory positions between these graduates and ART's.

To coincide with this stratification of medical technologists there has been a change in the mix of medical laboratory technologists now employed in laboratories. This change not only applies to the hierarchy of medical laboratory technologists but also to their relationship to other laboratory manpower groups. Such changes in British Columbia hospital laboratories have been identified previously in a study by Stark on the likely demand for medical laboratory technologists in B.C. from 1979 to 1984.(70)

That study demonstrated a steady decline in the number of non-registered technologists employed and a steady increase in the number of registered technologists. As a percentage of total laboratory staff, the number of non-registered technologists decreased from 5.1% in 1970 to 2.7% in 1976 while the number of registered technologists increased from 61.6% in 1970 to 64.5% in 1976. Of particular interest is the finding that the proportion of ART's remained relatively stable throughout the study period within a range of 4.7% to 5.7% of the total while the number of Licenciates actually showed a slight decrease from 1.1% in 1970 to 0.6% in 1975. Also of interest is the finding that the number of technical assistants increased throughout the study period from 5.1% of the total in 1970 to 9.3% of the total in 1976.(70) It should be pointed out that this included laboratory personnel employed in both the public and private sector laboratories.

In theory, certification as a Registered Technologist is voluntary and not required for employment in a clinical laboratory in B.C. In practice, most collective agreements between B.C. hospitals and laboratory workers require CSLT registration as a condition of employment. Non-registered technologists may be hired although they are generally paid at a lower rate. In B.C., "qualified-not-registered" technologists are paid 10% less than registered technologists. It may be this financial incentive that has led to the decrease in the number of non-registered technologists. Since the hospitals are generally under pressure to hire only CSLT registered candidates, the number and availability of

RT's will have a significant impact on the number of positions available to non-registered technologists.

The change in the percentage of technical assistants employed in B.C. hospitals is of considerable significance. It signifies a further stratification of laboratory workers from a simple grouping of pathologists and technologists. It demonstrates a specialization of the technologist's role wherein the more highly trained and skilled workers do not spend their time doing less demanding jobs more appropriately performed by less skilled workers. With the various levels of skills and responsibilities come various levels of financial rewards. It then becomes a management function to ensure the most appropriate workers are used for particular tasks.

There are many tasks in the laboratory that do not require the skill of a registered technologist. Hospital laboratories in British Columbia do not appear to make as much use of the technical assistant as do laboratories in Ontario. The Canadian Society of Laboratory Technologists approved a Syllabus of Studies for laboratory assistant training programs in 1973. Prior to that time, laboratory assistants were trained through on-the-job experience which meant that they were only trained in certain tasks, had little or no training in general science or general laboratory techniques, and therefore did not have the flexibility to change their role easily or to meet the needs of a different laboratories. Several colleges in Ontario now offer laboratory assistant training programs while B.C. still relies on on-the-job training and in-migration of qualified workers from other provinces and countries.

It has been suggested that the issue of a training program for laboratory assistants in B.C. has been deliberately avoided in order to avoid a repeat of the experience with Licensed Practical Nurses (LPN´s).(71) As the number of LPN´s became more prominant in the nursing workforce, their union, the Hospital Employee´s Union, was able successfully to negotiate wage increases for their members that brought the wages of LPN´s very close to the starting salary of Registered Nurses (R.N.´s) who had considerably more education and responsibility. Subsequently the nurses´ bargaining agent naturally negotiated a wage scale that would restore an acceptable wage differtial between the R.N.´s and L.P.N.´s. The effect of this scenerio was to increase dramatically the cost of health care within the terms of a single contract, as the wage increase offered nurses was approximately 40% over the life of the contract.

Hospital administrations are, naturally, very anxious to avoid another situation that could have so dramatic an effect on the operating cost of their facilities. This has, however, given rise to another problem. Medical Laboratory Technologists have traditionally been paid at a level comparable to that of Registered Nurses. Following the "catch up" settlement for nurses, the technologists have been trying, so far unsuccessfully, to restore the historical wage parity with nurses. This is certainly going to be a key issue to be resolved in future negotiations between the hospitals and the bargaining agent for the technologists.

Two manpower surveys in Ontario for 1974 and 1976 demonstrate the prevalence of laboratory assistants in that province.(72) The 1974 survey included 71 hospitals and found the 200 laboratory assistants accounted for 12% of the total technical staff. The study did not include laboratory aides who are generally combined with laboratory assistants to form the "other technical staff" category in B.C. hospital statistical reports.

The 1976 Ontario survey included 52 hospitals and 62 private laboratories. This study found that technical assistants accounted for 12.5% of the total technical staff and that they were used in virtually all areas of the laboratory except Blood Bank. Significantly, this survey found that private laboratories used a larger proportion of technical assistants than did hospitals. This may be largely due to the profit orientation of private laboratories although it may also reflect the nature of the work private laboratories perform. Because private laboratories deal largely with a relatively healthy clientele, the tests performed for this population may be mostly of a routine nature. Such tests are easily batched on highly automated equipment.

As mentioned previously, the number and availability of registered technologists will have an effect on the mix of laboratory personnel. Financial incentives to become registered, union pressure to hire only registered technologists, and the availability of registered technologists in B.C. all influence the mix of laboratory personnel employed.

Figures for the period 1970 to 1976 indicate there was an average annual increase in the number of Full Time Equivalent (FTE) positions of 5.5% for medical laboratory technologists in British Columbia(73). This coincides with approximately 54.4 FTE´s per year in new positions. B.C. colleges and institutes graduate an average of 80 students per year as general RT´s. It is estimated that roughly 20% of those will find employment in private laboratories and another 11% in other laboratories. That leaves 56 new graduates every year for the estimated 54.4 FTE positions. As the vast majority of medical technologists are women, there is a larger attrition rate due to family rearing. It would appear that, even with the addition of the subject RTs to the workforce, the supply of registered technologists is far short of the demand. However, the apparent shortfall is more than made up by the national migration of registered technologists to British Columbia.

A recent survey by the CSLT shows B.C. to be a net importer of registered technologists in increasing numbers.(74) In 1971, B.C. received a net increase of 35 RT´s from across Canada while in 1981 the net increase was 109. Ontario is the largest loser in the net migration pattern with a 1981 loss of 140 registered technologists. The reasons for such migration activities have not been well documented but could include regional pay diffentials, movement of spouses, and lack of positions in provinces where there is a net loss through migration.

Statistics Canada figures add an interesting perspective to the above surveys. The number of registered technologists and non-registered techologists per capita has almost doubled in the last decade in British Columbia and has been well above the national average throughout that period.(75) One could question why the apparent demand for technologists of the last decade did not give rise to substantial increases in B.C.´s own graduates in medical technology.

MANPOWER PLANNING DEFINITIONS AND OBJECTIVES

Manpower planning has been defined as having the right number and the right kinds of people, at the right places, and at the right time, doing things which result in maximum long-term benefits for both the organization and the individuals.

The goals in manpower planning might be considered to be:

1. to reduce to a minimum the quantitative and qualitive imbalance on the labour market due to the inadequacy and unsuitability of both the labour force and employment opportunities;

2. to provide the environment necessary for bringing supply and demand together in such a way that the objectives of economic growth with stability in prices and self realization in work for the individual are promoted in an optimum way.(76)

There are essentially four different approaches to manpower forecasting:(76) 1) The International Comparison approach simply involves comparing the employment patterns of various countries at various stages of economic development. The assumption is that if country X has a certain employment or occupational structure at a certain point in its economic development and country Y is expected to reach that level of economic development at some future date, then at that time, country Y should theoretically experience an occupational structure similar to that experienced previously by country X. This approach has not proven very successful due to the difficulty in comparing international data on occupations and education. 2) The Statistical Trends approach merely extrapolates the past into the future without consideration of technological changes occurring at a more rapid rate and having a greater impact than in the past. This approach also assumes the appropriate balance between the supply and demand for manpower exists at the time of the extrapolation. 3) The Industrial Survey approach aims at determining the existing occupational and educational mix of a particular industry then combines this information with expert opinions on the rate of technological changes in progress, the growth expectations of the industry and the possible occupational mixes of the future. A key factor in this approach is the accuracy of the expert opinions. 4) The Econometric model approach involves identifying the relationships between employment and its various parameters. This approach uses the incremental study of several such relationships which may be influenced through various means, such as legislation, and thus, may provide an avenue to exert controls in appropriate places within a model framework and to have a more complete picture of the probable outcomes. This approach is the most complex and difficult to do but also has the potential to provide the most accurate manpower projections.(76)

As is discussed in subsequent sections of this study, health manpower planning in British Columbia has involved each of these forecasting methods to a certain degree of however, the primary activity in forecasting manpower needs in the health care sector in B.C. has been in international (and national) comparisons and statistical trends. These methods are the easiest to use and require the least information in terms of a data base. They are also the least accurate and do not take into account on-going changes in the the provincial economy, government policy, and technology. Such factors are taken into consideration in industrial surveys and econometric models, however, use of these approaches in B.C. is only in the embryonic stage.

HISTORICAL DEVELOPMENTS IN HEALTH MANPOWER PLANNING IN BRITISH COLUMBIA

Traditionally, British Columbia has been a net importer of health care manpower.(11) The Hamilton Report noted that prior to 1949, B.C. relied heavily on its ability to attract health care workers from other provinces and countries, generally to the detriment of the supply of qualified health care workers in this province.(11) As part of their mandate, Hamilton and Associates reviewed the supply of health care workers in 1949 and noted substantial shortages in personnel, particularly nurses. In addition to the short supply of health care workers, including physicians and medical laboratory technologists, Hamilton also noted the poor distribution of physicians and the variable quality of training programs for medical laboratory technologists.

Among the recommendations of the Hamilton Report was a call for the immediate enrollment of 50 students per year in the soon-to-open medical school at U.B.C. It was noted that the distribution of physicians at that time varied from 1:810 people in metropolitan areas to 1:2500 people in isolated areas. It was hoped that the training of B.C. residents would improve that distribution as graduates returned to their home towns to practice medicine. Hamilton also called for an increase in enrollment in the province's six nursing schools, estimating there was a current shortage of 4,412 nurses in 1949. The Report also recommended the standardization of medical laboratory technologist training programs and a better distribution of training facilities.(11)

The next concerted effort to review the province's policies and directions related to health manpower planning came in 1973 with the Foulkes Report.(12) The Foulkes Report was a plan for the overall reorganization and reorientation of the province's health care delivery system. Foulkes noted the majority of B.C. physicians were trained outside the province and that of the 60 to 65 graduates from U.B.C. every year, most tended to stay in the province as family practitioners whilst specialists were recruited from outside the province. He recommended that the province accept responsibilty for training its own medical manpower provided that the supply of physicians produced could be absorbed by the demand for their services. He noted that in order to bring B.C.'s training of physicians up to the level of the national average per population, the province would have to graduate 152 new physicians every year.

Although there were no specific recommendations directed towards medical laboratory technologists, it was noted that the Provincial Civil Service had no inventory of manpower skills and recommended the adoption of manpower planning throughout the Civil Service Commission.(12) It should not be unexpected that physicians receive the bulk of the attention when it comes to manpower planning in health care. It is physicians who drive the system and each additional physician has been estimated to cost the system up to $250,000 per year.(77)

Almost in conjunction with the Foulkes Report came the establishment of the B.C. Medical Centre with its mandate to advise and assist in the development and improvement of health manpower training programs and facilities. The B.C.M.C. Education Sub-Committee reviewed clinical training facilities for physicians and paraprofessional health care workers such as nurses and physiotherapists.(15) The Sub-Committee made widespread recommendations for the upgrading of existing facilities for training clinical manpower but made no recommendation regarding specific numbers to train.

A parallel effort in manpower planning cooperated closely with the work at B.C.M.C. and was precipitated as a requirement of the federal- provincial health manpower committee. The Health Manpower Working Group was established in 1973 and its research arm, the

Health Manpower Research Unit, began compiling statistics on the supply and demand for various health manpower groups.(73)

The first study directly related to forecasting the need for medical laboratory technologists in B.C. was published by the Health Manpower Research Unit in March 1979.(70) Its recommendation was essentially for the maintenance of the status quo, as far as student enrollment in the province's training facilities were concerned, for the next five years.

Also in 1979, W.D. Black undertook a study on medical manpower in the province of B.C.(62) Among his recommendations were that U.B.C.'s medical school should not expand unless supported by needs forecasts considering both provincial and national needs. It also recognized the poor distribution of B.C.'s physicians and suggested the government help small communities attact physicians by building better facilities in such communities and consider restrictions on physician billing numbers to help temper the supply and maldistribution of physician manpower.(62)

British Columbia has recently participated in another effort to coordinate manpower training between the western provinces. The Western Canada Health Manpower Training Study was initiated by the Premiers of the western provinces at their annual conference in 1980.(78) The objectives were to assess the existing and future needs for health manpower training programs and facilities in western Canada and to make recommendations for the rationalization of the location and funding of health manpower training programs.

The study took place over a two year period and consisted of a review of 26 health occupations including physicians and medical laboratory technologists. The study makes projections of manpower needs from 1981 to 2000 based on the most likely scenario of population growth. The conclusion of this study was that B.C. would need an additional 40 medical technologists per year from 1981 to 2000 over and above the current output at the time of the study of about 80 new graduates per year. This projection assumes the existing 1980 migration patterns in favour of B.C. will remain unchanged and the existing ratio of technologists to population will remain appropriate.

THE HEALTH MANPOWER PLANNING ORGANIZATION IN BRITISH COLUMBIA

British Columbia's current efforts in health manpower planning are related to developing a statistical data base from current and historical manpower levels by occupation.(78) The Health Manpower Working Group plays the central role in health manpower planning in B.C.(78) It is composed of senior officials from the Ministry of Health, the Ministry of Education, the Ministry of Universities, Science and Communications, and the Ministry of Labour. The Health Manpower Working Group reports to the Deputy Minister of Health and advises the Ministries of Education and Universities, Science and Communications on the needs for health personnel. The Working Group is responsible for coordinating appropriate health manpower studies, reviewing policy issues affecting health manpower, assessing the manpower implications of proposed health care programs and reviews proposals for the establishment of new types of health care workers.(78)

The Health Manpower Research Unit of the Division of Health Services Research and Development at the University of British Columbia serves as the primary research resource to the Working Group. It maintains data on 29 health occupation groups.(79) Manpower requirements are estimated using manpower ratios, surveys of specific professions, institutional vacancy surveys, medical service utilization and periodic graduate follow-up surveys. It also conducts special surveys of health agencies to determine current and future manpower requirements for specific occupations.

The Health Manpower Research Unit has developed a computer model for projecting health manpower supply known as the General Manpower Stock Simulator Model. It was initially designed to project the supply of physicians and dentists and to analyze the effects of policy options on supply and distribution of manpower. The model can be used for any occupational group providing there is a sufficient data base.(78)

The overall responsibility for coordinating provincial manpower needs lies with the Manpower Needs Committee of the provincial government. Health Manpower requirements are directed to this Committee through the Ministry of Labour which is advised by the Health Manpower Working Group.(78)

Two other organizations having input into the health manpower planning process are the British Columbia Health Association and the Education Health Advisory Committee. Both of these organizations liaise with the Health Manpower Working Group through both formal and informal channels.(78)

It is the Ministry of Health that identifies health manpower needs and advises the Ministries of Education and Universities, Science and Communications on the size and number of programs and distribution of graduates. The Ministry of Health also establishes special task forces as required to deal with specific health manpower issues.(78)

The Ministry of Education is represented on the Health Manpower Working Group by the Coordinator of Health and Social Service Programs who is responsible for reviewing and coordinating health and social service programs at the colleges and institutes. The Coordinator reports to the Director of the Program Services Division, Post-Secondary Education, who is responsible for curriculum development at colleges and specialized institutes.(78)

The Ministry of Labour is responsible for apprenticeship training policies, occupational forecasting, liaison with the federal government on immigration, and consultation with provincial ministries, industries and other agencies on manpower issues.(78)

The Education Health Advisory Committee was established by the Academic Council to assist in the planning of health education in the province. The objective of the Committee is to develop effective training programs and facilities for health manpower. It liaises with the Health Manpower Working Group through the Executive Director of Planning, Policy, and Legislation of the Ministry of Health who sits on the Committee.(78)

The above organization does provide an avenue for appropriate interaction between parties involved in most aspects of manpower planning in B.C. This system provides the basic foundation of information on which political decisions are made with regard to the supply of the various health manpower groups.(78)

HEALTH MANPOWER EDUCATION IN BRITISH COLUMBIA

Administrative Organization

The colleges, institutes and universities are managed by autonomous boards and each is responsible for its own educational planning. Each institution cooperates with the Health Manpower Research Unit in the preparation of a biennial status report on the production of health and human service personnel.(79)

The Academic Council is the lay body, established under the Colleges and Institutes Act, charged with resposibility for reviewing annual budget submissions from the colleges and institutes. The Academic Council submits an annual budget request to the Minister of Education and then allocates the approved funds to individual institutions.(78)

The Universities Council is the lay body established under the Universities Act and serves as an intermediary body between the three universities and the provincial government. The Council reports to the Minister of Universities, Science and Communication and is responsible for funding and approval of programs. Existing programs are funded on a formula basis while new programs are funded through a separate mechanism. When new health programs, or changes to existing programs are considered, the Council may seek the advice of the Educational Health Advisory Committee.(78)

Medical Laboratory Technologist Programs

Medical Laboratory Technology courses are offered by the B.C. Institute of Technology (B.C.I.T.), Camosun College, Cariboo College, College of New Caledonia, Malaspina College, and the University of British Columbia. B.C.I.T. and Cariboo College are the only intitutions providing a full two year academic program and which coordinate the third year practicum required before eligibility to write the certification examinations of the Canadian Society of Laboratory Technologists (C.S.L.T.).(79) The other community colleges offer a one year academic program in medical technology designed to be transferable to one of the institutions offering a complete program. The University of B.C. offers a bachelor's degree program in medical laboratory sciences.

In 1979, B.C.I.T. and Cariboo College graduated 82 medical laboratory technologists for a ratio of 3.20 per 100,000 population. In 1980, there were 78 new graduates in B.C. for a ratio of 2.92

new graduates per 100,000 population. On the other hand, the rest of Canada graduated 952 new medical technologists in 1980 for a ratio of 4.45 per 100,000. (79)

Historically, B.C.'s contribution of new medical technologists has declined steadily since the early seventies from 95 in 1971 to 78 in 1980.(79) In 1984, B.C.I.T. graduated about 50 medical technologists and Cariboo College graduated about 15.(80)

The number of graduates in B.C. is clearly declining and is considerably below the national average. B.C. is a net importer of medical technologists in growing numbers from other Canadian provinces. This trend is indicative of the general Canadian migration pattern towards B.C. but may also be the result of unstated political policy.

The training programs for medical technologists are very expensive and if B.C. is able to reap the benefits of other provinces' efforts there can be substantial financial savings. There is a risk element associated with such a policy related to pressure from other provinces not wanting to lose their graduates to B.C. and from the electorate who may see job opportunities in their home province going to outsiders.

One of the issues related to the current decline in numbers of B.C. medical technologist graduates is the question of who pays for their training. At present, the colleges and institutes of B.C. are funded through the provincial Ministry of Education. The third year practicum for medical technologists which occurs in hospitals or private laboratories is funded by that particular institution and hence the Ministry of Health. At a time of wholesale program cuts in all ministries, there is considerable concern over which ministry should be responsible for the education and training of medical technologists. Budgetary constraints in some hospitals have led to a reduction in the number of students taken into their programs in recent years, as money formerly allocated to student training is directed towards the employment of qualified personnel to assist with the laboratory's workload. This decline in student positions is related directly to this conflict between the Ministries of Health and Education over who should pay. Until this conflict is resolved it is possible that further cuts in enrollment may occur as third year placements decline, thereby increasing B.C.'s dependence on out-of-province manpower resource.

THE EFFECT OF AUTOMATION ON LABORATORY MANPOWER

The question of whether technological advancements, particularly automation, have an effect on manpower utilization in laboratories has been discussed by many for some time now but a definitive answer still is not available. A review of the literature shows a dearth of detailed studies regarding this subject. Two studies undertaken in British Columbia suggest there must be some impact on manpower through increased laboratory automation although the degree of impact could not be defined.(70,81)

The study undertaken on behalf of the Health Manpower Working Group in 1978 concluded that the considerable increase in automation over the period 1972-1976 had not led to a reduction in the number of laboratory staff since there had been a yearly increase of 5% in the number of Medical Laboratory Technologists for that period.(70) Data for this study were obtained through statistical reports and a questionnaire circulated to all Medical Laboratories in B.C. This study also found only a modest increase in the proportion of Technical Assistant positions in relation to the number of Registered Technologists. Admittedly, these data were only available from a relatively small number of hospitals and the overall study period covered only five years. This may have been an insufficient data base on which to form any definitive conclusions.

The second B.C. study undertaken in 1981 involved a questionnaire designed to develop a data base by which a number of broad impact questions could be answered regarding technology in laboratories.(81) Although the study group was relatively small (30 respondents) the researchers felt their responses were reasonably representative for the province. It was the consensus of the respondents that automation does save time for staff. However, none of the hospitals actually reduced staff due to automation. Any time saved was used to absorb workload increases in other laboratory functions. In addition, most of the respondents felt that, to date, automation had not replaced the technologist or reduced the current demand for staff, although many did suggest that future demand for technologists will be reduced and there will likely be considerable impact on the technologist's career path. As instrumentation becomes simpler to operate, the operators require less sophisticated skills to perform their tasks while laboratory supervisors and senior technologists will need more skill in trouble shooting instruments. This could result in a widening of the gap in skills between junior and senior registered technologists.

A subsequent study involving Vancouver General Hospital estimated that without the increase in automation over the period 1971-1979, the laboratory would have required a 76% increase in staff in order to accommodate the 1980/81 laboratory workload.(57)

It is clear from these studies that automation does have a significant impact on laboratory manpower; that being its ability to increase the number of tests per FTE and thus reduce staff, or at least slow the rate of increase in laboratory staffing levels. However, this effect appears to be more than offset by another apparent aspect of automation; that being its ability to increase the availability of tests to physicians, hence increasing the number of tests per acute care admission. How these two aspects of the relationship between automation and manpower interact is the subject of considerable attention, particularly with regard to attempts at controlling one or both of these parameters.

CHAPTER VII

THE ORGANIZATION AND OPERATION OF A HOSPITAL LABORATORY

The role of the clinical laboratory in hospitals may be considered to be one of providing physicians with meaningful information related to the current biochemical and biological condition of their patients. To provide this information in the most efficient and cost-effective manner requires laboratories to have, among other things, a suitable organizational structure. The organizational structure may vary from the very simple to the very complex depending on the hospital size, function and laboratory workload.

Laboratories in hospitals accreditated by the Canadian Council for Hospital Accreditation are required to enlist the services of a qualified physician as their director.(82) Typically, the Director is a specialist in Pathology and could report to the hospital's medical director or administrator. The Director's qualifications may be as a general pathologist or as a specialist in one the disciplines of laboratory medicine.

Larger laboratories are generally divided physically and administratively into sections based on the category of laboratory test. The laboratory could include sections in Hematology, Chemistry, Microbiology, Histology, Immunohematology (Blood Banking), and Accessioning (specimen collection and handling) among others. There may be more sections or sub-sections depending on the size of the laboratory. For the sake of operational and administrative efficiency, some of the above major sections could be amalgamated or sub-sectioned as required.

Each section of the laboratory typically has a supervisory technologist overseeing the activity of that section. The supervisory technologists are generally responsible for maintaining that sections' operational integrity and for ensuring that laboratory and hospital policy and procedures are adhered to. The supervisory technologist may report to either the laboratory director or to one of the medical specialists in that particular discipline designated responsible for the section.

The largest sector of the laboratory's workforce are medical laboratory technologists who perform the bulk of the testing procedure. They are often assisted in this task by laboratory technical assistants who assume responsibilty for the less technical aspects of the testing procedures. They are often involved in specimen preparation and perhaps some aspects of automated equipment operation. Many laboratories also enlist the services of clerical personnel to process the necessary paperwork accompanying each laboratory request. In B.C. public hospitals, medical laboratory technologists are members of the Health Sciences Association which bargains collectively on their behalf, while technical assistants and clerical staff are members of the Hospital Employees' Union.

Technologists may either rotate through all laboratory sections, or disciplines, and maintain their flexibility or, as is often the case in larger laboratories, they may stay in a single section becoming expert in the many aspects of that particular discipline.

The laboratory workload is initiated by a physician making a request for a particular laboratory test to be performed on one of his/her patients. Depending on the hospital's organization and role in the community, the patient may be either an inpatient or an outpatient. The specimen is collected by either the physician, a nurse, or by the laboratory phlebotomists. Again, depending on the size and organization of the laboratory, the specimen will be directed to the section performing the particular test ordered. A single specimen may be separated into several aliquots for multiple tests.

In addition to the patients' specimens, the laboratory will also process a certain number of standards or knowns as a method of measuring the accuracy and reproducibility of the procedure and equipment. Hospital laboratories generally subscribe to a variety of quality control programs which dictate the minimum frequency with which control specimens should be tested. Some quality control programs also include a number of "unknowns" which are periodically tested in the subscribing laboratory. The results of these tests are then compared to that reported by all the other laboratories subscribing to the program. A high level of quality control is essential for confidence in the accuracy of the result reported on a clinical specimen and is required by the various accrediting bodies of laboratories.(82)

Hospital laboratories in B.C. are rated and accredited by the B.C. Medical Association in conjunction with the B.C. Association of Laboratory Physicians.(83) The length of the accreditation varies with the laboratory's compliance with recommended operating standards. Hospital laboratories are also accredited by the Canadian Council On Hospital Accreditation which sets organizational and operational standards for Canadian hospitals.(82)

Each laboratory test and control standard is recorded and given a unit value representative of the total technical and clerical time required to handle and process that specimen from its receipt in the laboratory to the sending out of the final report. The unit values are usually the ones defined by the Canadian Workload Measurement System for Laboratories and published by Statistics Canada. It is the total of these unit values that are used in management reports related to laboratory productivity. These measurements are also used by governments in justifying funding levels and, hence, staffing levels.

Laboratories may be funded in several different ways. Until recently, when the provincial government adopted a global funding approach to hospital budgets, the government provided hospitals with what it felt were sufficient funds to operate their laboratories based on the workload statistics reported by that laboratory. The budget was generally divided into personnel, operating supplies and expenses, and capital expenses. The personnel budget was assigned according to a calculation of workload units per FTE, with the level being set somewhat arbitrarily by the Ministry, based on historical patterns and current expectations. Operating supplies were budgeted largely on previous requirements plus new programs, while capital equipment was financed on an "as needed" basis.

Hospitals now have more flexibility on how they budget for their laboratory operation and may use any of a variety of budgeting techniques, from allocations based on historical data, to line or program budgeting such as Zero Base Budgeting.

CHAPTER VIII

FINDINGS AND IMPLICATIONS

LABORATORY MANPOWER IN BRITISH COLUMBIA HOSPITALS

The impact of the changes in the demand for laboratory services and in the system's ability to meet that demand are reflected in laboratory manpower utilization data and in laboratory operating expenses. This chapter presents data related to how the number and mix of laboratory personnel in B.C. hospitals has changed over the study period and how the operating costs for B.C. hospital laboratory services have also changed.

Definitions and Limitations

Because of changes in the reporting requirements, data for 1966 are not as detailed as those of subsequent reporting years. Reported categories in 1966 include laboratory technologists, qualified and unqualified, which is equivalent to registered and non-registered technologists and qualified and unqualified technicians which were both included in the category of Technical Assistants. The difference between the sum of these two categories and the reported total laboratory positions were assumed to be part of the administrative support staff and reported under "Other Laboratory Staff".

All laboratory personnel are reported in terms of Full-Time Equivalents (FTE). An FTE is a calculation of the number of paid hours equivalent to one full-time worker; for example, 7.5 hrs/day x 5 days/wk x 52 wk/yr = 1950 hours per year. The total recorded accumulated paid hours per year for each personnel group was divided by 1950 hours to obtain the number of FTEs in each category.

Six categories of laboratory personnel have been examined in this study. Each category is based on professional and educational qualifications and functional roles within the laboratory. The six categories include: Laboratory Physicians; Laboratory Scientists; Medical Laboratory Technologists; Non-Registered Technologists; Technical Assistants; and Other Laboratory Staff. The categorization and definition of each manpower group is according to the instructions and definitions provided for the completion of the HS-1 returns.(1)

The category of Laboratory Physicians includes pathologists and other physicians in the laboratory. Pathologists are physicians certified in the specialty of pathology by the Royal College of Physicians and Surgeons of Canada. Other medical staff refers to persons with a medical degree who are not certified pathologists.

The category of Laboratory Scientists includes persons qualified to practice as medical laboratory scientists, by reason of having graduated from a recognized university with a degree, majoring in an appropriate laboratory discipline. Recognized degrees in this category include B.Sc., M.Sc. and Ph.D. Persons in this category could include Biochemists, Microbiologists, Immunologists, Physicists et cetera.

The category of Medical Laboratory Technologists refers to persons qualified to practice as medical laboratory technologists by meeting the requirements for certification by the Canadian Society of Laboratory Technologists (CSLT) or equivalent standards. This category includes those persons holding any level of CSLT certification (RT,ART,Licentiate) who are currently registered with the CSLT or those who have sufficient qualifications to assure registration should application be made. Certification and registration are not essential for practice but are normally required by employers.

Non-Registered Technologists refers to persons employed as laboratory technologists who are neither registered with the CSLT nor hold equivalent qualifications or registration, nor are they eligible for such registration.

Technical Assistants refers to those persons qualified through a formal course to function as a laboratory technician but who are not qualified for registration with the CSLT as a medical laboratory technologist. This category includes combined Laboratory and Radiological Technicians, Laboratory Aides, Laboratory Assistants, and Graduate Nurses working in laboratories.

Other Laboratory Staff includes administrative support personnel such as clerks and secretaries.

Non-Medical Laboratory Personnel

Table VI presents the data collected for all laboratory personnel groups, excluding Laboratory Physicians who are dealt with separately. Manpower totals are presented in FTE´s as calculated from total paid hours reported in the HS-1 returns. Data presented in Table VI are for all hospital size groups combined. Data related to individual size groups is presented in Appendix 2. Because of differences in the definitions and reporting reguirements of the HS-1 returns, data for 1966 were not directly comparable to the subsequent reporting years and were therefore omitted from this analysis. Where indicated, the differences between 1970 and 1980 have been tested for significance at p=0.05 and in all cases, $|Z| > 1.96$ indicating the proportions tested are indeed significantly different.

It is readily apparent (Table VI) that there has been a significant decline in the number of Laboratory Scientists. In the period from 1970 to 1980, the actual number of Laboratory Scientists has declined by 14.5 FTE from 35.1 to 20.6 FTE and, as a percentage of overall laboratory manpower, has ranged from a high of only 2.9% in 1970 to a low of 0.8% in 1978. There was a slight recovery in numbers in 1980 to 1.0% of the total laboratory manpower. This trend is consistent throughout the various hospital size groups but is particularly so in the larger hospitals of Groups IV and V (see

Appendix 2).

This change in the number of Laboratory Scientists is likely a reflection of the changing standards of laboratory directors and possibly of the supply of laboratory physicians.

There has been a similar decline in the number and proportion of Non-Registered Technologists. The aggregated data for all hospitals shows the number of Non-Registered Technologists declining from 62.6 FTE in 1970 to 30.8 FTE in 1980. As a percentage of the total, the proportion declined from a high of 5.1% in 1970 to a low of 1.5% in 1980. This trend is most consistent and dramatic in the smaller hospitals of Groups I, II and III. The same trend is evident in Group IV hospitals although there are signs the decrease may be leveling off. This is even more evident in Group V hospitals where it has remained around 2% of the total laboratory manpower from 1974 to 1980.

The change in the number of Non-Registered Technologists may be due to members of that category either leaving the workforce or taking their certification examinations with the CSLT. Before the CSLT became such a prominent body in certification and in employment of medical laboratory technologists, many more technical employees were not registered because the accepted alternative to CSLT certification was on-the-job-training.

The Health Sciences Association (HSA) contract, which governs the employment of medical laboratory technologists in most B.C. hospitals, requires non- registered technologists to be paid 10% less than CSLT registered technologists. In addition, the HSA encourages the inclusion of CSLT registration in all laboratory job descriptions.

The number of Medical Laboratory Technologists for all hospitals has increased from 755.1 FTE in 1970 to 1366.4 FTE in 1980 and as a percentage of total manpower in laboratories, has increased from 61.7% in 1970 to 67.3% in 1980. This increase in registered technologists is consistent for all hospital size groups and it will be noted that, generally, registered technologists make up a larger proportion of the total laboratory workforce in the smaller hospital size groups. Much of this increase is due to the reduction in Non-Registered Technologists through whatever means.

TABLE VI
The Number and Percentage Distribution of Laboratory Personnel in B.C. Public Hospitals and Total Percentage Change from 1970 - 1980, by Type of Personnel

Laboratory Personnel Classification	1970		1974		1978		1980		TOT
	FTE	%	FTE	%	FTE	%	FTE	%	%
Laboratory Scientists	35.1	2.9	18.9	1.3	13.7	0.8	20.6	1.0	-41
Registered Technologists	755.1	61.7	938.7	65.5	1144.4	66.8	1366.4	67.3	+81
Non-Registered Technologists	62.6	5.1	33.4	2.3	36.6	2.1	30.8	1.5	-51
Other Staff, Technical	83.9	6.9	106.0	7.4	120.2	7.0	146.7	7.2	+75
Other Staff, Laboratory	287.4	23.5	336.7	23.5	399.1	23.3	465.4	22.9	+62
TOTAL	1224.1	100	1433.6	100	1714.0	100	2029.8	100	+66

FTE = Full Time Equivalent
% = Percentage of total non-medical laboratory personnel.
TOT % = Total percent change from 1970 to 1980

The number of Technical Assistants has remained relatively constant from 1970 to 1980 ranging from a low of 6.9% of total laboratory manpower in 1970 to a high of 7.4% in 1974. This is somewhat different from the earlier findings by Stark which showed technical assistants to comprise 5.19% of the total laboratory FTE in 1970 and 9.3% of the total in 1976.(70) That study separated graduate nurses from technical assistants. As there is no such separation for HS-1 data recorded for 1978 and 1980, I have chosen to combine these laboratory workers as technical assistants throughout the study period. Allowing for this combination, the respective figures of both studies are complementary.

The trends have been somewhat variable between the various size groups with a generally decreasing trend in Group One, relative stability in Groups Two and Four, and an increasing percentage in Groups Three and Five. The largest variance between 1970 and 1980 is in Group Five with a spread of only 2.5% indicating that while the increasing trend is apparent, it is of a very modest magnitude.

It was anticipated that increased automation would lead to a reduction in the proportion of Registered Technologists with a corresponding increase in the proportion of Technical Assistants. The overall change in the proportion of Technical Assistants is very small and, indeed, there are fewer in 1980 than in 1974.

It is unclear why this anticipated effect of automation on manpower has not been manifested in this study. It may be that while there are certainly cost advantages to employing less highly trained workers, there are also disadvantages in that they are less flexible in what they are able to do. Given a choice of having either a technologist or a technical assistant with no consideration of costs, most laboratories would probably choose the flexibility of the technologist. Previous constraints from government appear to have been directed towards reducing FTE´s with no particular concern over the cost of those FTE´s. With the recent move away from deficit budgeting for hospitals, there will be real incentives to trade in dollars saved by employing more Technical Assistants for additional workers as funding from the Ministry of Health becomes increasingly tight. Union territorial protection also plays a significant role, as Technical Assistants usually are members of the Hospital Employees´ Union, and the Health Sciences Association representing medical laboratory technolosists would not like to see positions for its members lost to members of the HEU. Such an event could also lead to a narrowing of wage differentials between the technologists and assistants in much the same way as has happened between registered nurses and practical nurses. This will ultimately lead to increased overall costs if allowed to occur.

Failure to show this effect may also be due to the lack of qualified laboratory assistants in this province. As there is no formal training program for laboratory assistants in B.C., hospitals must rely on either on-the-job training, or on recruiting qualified personnel from other provinces.

An effort was made to identify the size of hospital where the employment of laboratory assistants becomes most feasible. The data presented in Appendix 3 shows the use of this manpower resource to be somewhat random, with some small hospitals using proportionately more laboratory assistants than large hospitals. It is apparent that there is no consistent pattern in the approach to employing this group of laboratory workers in B.C. hospitals.

A subset of data related to the composition of the registered technologist category was examined. Data were collected on the number of full-time and part-time Registered Technologists (RT´s), Advanced Registered Technologists (ART´s), and licentiates. Because of differences in reporting requirements between reporting years, the number of such technologists could not be collected in terms of paid hours and FTEs and so is not directly comparable to data presented above in Table VI. However, within the limitations of the accuracy and completeness of this data, the trends identified will be comparable. These data are presented in Table VII in aggregated form for all B.C. hospitals. Data grouped according to hospital size are presented in Appendix 4.

With the exception of 1978, the percentage of RT´s and ART´s has remained relatively constant throughout the study period when all hospitals are considered collectively, with RT´s accounting for approximately 89% of total technologists and ART´s accounting for approximately 10%. The 1978 data is of questionable reliability as the inordinately high number of licentiates were reported largely by a single Group IV hospital. The same is true of the seemingly high number of ART´s reported in 1978, where 65 of the 173 were reported by another single Group IV hospital. This seems unlikely when the 1980 values are so similar to the 1974 values. It is often clerks not associated with the laboratory who fill out the HS-1 Returns and such a clerical error may not have been noticed as being unusual.

The time frame of this study, as well as the basis on which the data were made available, did not provide an opportunity to verify the data with the particular hospital in question.

TABLE VII
The Number and Percentage Distribution of Registered Technologists in B.C. Public Hospitals by Qualification and Whether Full-Time or Part-Time: 1970-1980

Qual.	1970				1974				1978				1980			
	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%
R.T.	601	88	54	93	773	89	95	98	880	81	150	87	1067	90	201	98
A.R.T.	65	10	3	5	83	10	2	2	173	16	18	11	118	10	1	1
Licen.	12	2	1	2	12	1	0	0	38	4	4	2	2	0	2	1
TOTAL	678	100	58	100	868	100	97	100	1091	100	172	100	1187	100	204	100

FT = Full Time technologist
PT = Part-time technologist
% = Percentage change between periods has been rounded to the nearest whole number to conserve space.
Qual. = Level of qualification; R.T.= Registered Technologist;
A.R.T.= Advanced Registered Technologist; Licen.= Licentiate

When the individual hospital size groups are examined, some indications of change do become apparent (see Appendix 4). In the smaller hospitals of Groups I, II and III there is a general increase in the percentage of ARTs with a corresponding decrease in the percentage of RTs. There is very little activity surrounding Licentiates in these hospitals.

In the larger hospitals of Groups IV and V this trend is reversed. There is a slight increase in the percentage of RTs with a corresponding decrease in the percentage of ARTs. There are no consistent trends in the percentage of licentiates in these hospitals.

One of the expected effects of automation that has not yet developed in B.C. hospitals is the stratification of the technologist workforce. It was anticipated that there would be a move towards more ARTs, however, the overall proportion of the technical workforce holding their ARTs has remained relatively unchanged over this 15 year study period as was reported in a previous five year study of the same population.(70) Again surprisingly, the trends in the various hospital size groups are reversed from what was expected with the number of ARTs increasing in the small hospitals and decreasing in the larger hospitals.

The reasons behind this unexpected set of findings are not clear. Perhaps it is a reflection of the lack of preparedness of ARTs to fill the role expected by some hospitals. The hospitals may be using other manpower resources instead of ARTs such as professional managers, educators, and electronics engineers.

To put the growth in the overall number of laboratory personnel in a different perspective, it can be compared to the growth in laboratory workload in terms of workload per FTE. These data are presented in Table VIII. All hospital size categories experienced significant increases in the number of units per FTE from 1970 to 1980. The overall changes between 1970 and 1980 were substantially larger in the smaller hospitals, ranging from 22% in Group I hospitals to 9.7% in Group V hospitals. The combined data indicates an increase of 14.7% for the same period. The rate of increase between reporting years and size groups varied considerably, with only 1974 reporting significant increases for all size groups. In all other years there was a mixture of increases and decreases of varying magnitude. It is clear that automation has led to higher throughput per FTE, however, as workload units are continually adjusted to reflect automated methodologies, a more accurate representation of the impact of automation would be a measure of the number of reportable results (or tests) produced by each worker. Such information was, however, not available from the HS-1 returns but would undoubtedly show very large increases over such a study period.

TABLE VIII
Laboratory Workload Units per Laboratory Worker for all B.C. Public Hospitals by Size Group: 1970 - 1980
(workload units are in thousands)

Hospital Size Group	1970 units (x1000)	1974 units (x1000)	% C	1978 units (x1000)	% C	1980 units (x1000)	% C	1970-1980 %
Group I	94	108	15.2	107	-0.5	114	6.4	+22.0
Group II	105	122	15.6	121	-0.1	127	4.9	+21.1
Group III	103	136	31.9	120	-11.6	120	-0.3	+16.2
Group IV	97	109	12.3	147	35.3	110	-25.5	+13.2
Group V	105	108	2.8	118	9.2	115	-2.2	+9.7
TOTAL	101	113	12.1	123	8.6	116	-5.7	+14.7

units = workload units per laboratory worker, in thousands
% = Percentage change from previous period.

Physicians

The number of medical staff is reported in terms of full-time and part-time positions for pathologists and other paid medical staff. Most of the part-time positions are pathologists providing services to more than one hospital so that the total number of full-time and part-time medical staff is greater than the total number of laboratory medical staff working in B.C. hospitals.

Table IX presents the number of full-time and part-time medical staff positions in B.C. hospital laboratories. It does not include pathologists working on a sessional basis or those providing consultative laboratory services on a contract basis. The aggregated data for all hospitals shows the number of full-time pathologists has increased by 65.9% from 41 in 1966 to 68 in 1980. At the same time, the number of part-time pathologist positions has increased by 76.3% from 38 in 1966 to 67 in 1980. The change in the number of "other laboratory physicians" has been less consistent in terms of full-time and part-time positions, although the total number of positions is increasing. In 1974 there were 15 full-time and 8 part-time positions and in 1978 there were 4 full-time and 26 part-time positions. There is clearly a trend towards more part-time positions which is continued in 1980. This may be a reflection of the number of pathologists providing services to multiple hospitals or private laboratories.

On examining the data for individual hospital size groups, presented in Appendix 5, the increased presence of part-time pathologists continues to be evident in the larger hospitals of

Groups IV and V but the reverse is so in size Groups I and II. It will also be noticed that, with the exception of Group I hospitals, non-pathologist physicians are employed most extensively in the larger hospitals.

TABLE IX
Number and Percentage Distribution of Laboratory Medical Manpower in B.C. Public Hospitals: 1970 - 1980

Medical Manpower Category	1970				1974				1978				1980			
	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%
Pathol.	52	83	33	89	63	81	34	81	64	94	51	66	68	90	67	78
Other	11	18	4	11	15	19	8	19	4	6	26	34	8	11	19	22
TOTAL	63	100	37	100	78	100	42	100	68	100	77	100	76	100	86	100

FT = Full-time positions
PT = Part-time positions
% = Percentage of total FT or PT medical manpower rounded to the nearest whole number to conserve space.
Pathol. = Pathologists
Other = Other physicians employed in the laboratory.

LABORATORY WORKLOADS IN BRITISH COLUMBIA HOSPITALS

Laboratory workload is measured in workload units. Currently one unit is equivalent to one minute of technical, clerical or lab aide time required to perform a laboratory test. The system of measurement presently in use in Canada is called the "Canadian Workload Recording Method", originally developed under the direction of the Dominion Bureau of Statistics in 1954 by the Canadian Association of Pathologists. Current unit values are now published annually or semi-annually by Statistics Canada as the "Canadian

Schedule of Unit Values for Clinical Laboratory Procedures".(84)

The initial workload unit developed in 1954 was expressed as 10 minutes of time of which seven minutes were technical and three minutes supportive. This was quickly recognized as a very inflexible unit of measurement and did not adequately reflect the work resulting from quality control and the development of new procedures. Nor could it adequately reflect the changes being introduced by increasing automation and new procedures.

The Canadian Association of Pathologists, in conjunction with several other professional groups, undertook a revision of the so-called DBS unit and published, in 1969, a new schedule of unit values for clinical laboratory procedures. This new schedule was based on time/motion studies of laboratory procedures performed in 49 hospitals and introduced the unit as being equivalent to one minute of technical and aide time. The new unit and unit schedule were designed to provide a realistic assessment of the total technical, clerical, and aide time consumed in the performance of laboratory procedures including quality control, research, development, et cetera.

Because of this difference in unit values, laboratory workload statistics from 1966 are not comparable to subsequent years and are, therefore, not included in the following presentation and analysis of laboratory workloads in British Columbia hospitals.

Table X presents the distribution of laboratory workload units by laboratory service for all hospitals. Laboratory workloads in individual hospitals size groups are presented in Appendix 6. It should be noted that not all small hospitals categorized their laboratory workload into the various laboratory services indicated on the HS-1 Returns but merely reported total workload. For this reason there are several cases in Group I hospitals where the sum of laboratory workload from the various services does not equal the reported total workload for that year. In such situations, the total of the categorized workload is reported in brackets and the calculation of "Percent of Total" is based on this figure. It should also be noted that the data in Table X only represent the total workload performed by hospitals falling within the specified size categories and do not make any allowance for the changing number of hospitals and beds in each size group between reporting periods.

When the data are aggregated for all hospitals it is clear that, almost without exception, workload increased substantially in all laboratory services and all reporting years. For the 11 year period from 1970 to 1980, the total laboratory workload for all hospitals increased by 90%. However, it does appear as though the rate of increase may be slowing.

Table X also displays the proportion of total laboratory workload subdivided into the individual laboratory service categories. Relevant differences in proportions have been tested for statistical significance at $p=0.05$. All differences were found to be significant with $|Z| > 1.96$, but it will be noted that, overall, there has been relatively little change in these proportions with only a few exceptions. The proportion of workload attributable to Blood Banking increased from 8.2% of total workload in 1970 to 11.5% in 1980 and the proportion of Procurements increased from 7.7% of the total in 1970 to 11.6% in 1980. The proportion of Microbiology decreased slightly during the same period from 19.3% of the total to 16.5%.

TABLE X
Distribution of Laboratory Workload for all B.C. Public Hospitals Showing Total Units by Service, Percent of Total Workload, and Percent Change From Previous Period: 1970 - 1980
(workload in 1,000's)

Category of Service	1970 units (x1000)	1970 % T	1974 units (x1000)	1974 % T	1974 % C	1978 units (x1000)	1978 % T	1978 % C	1980 units (x1000)	1980 % T	1980 % C
Chem.	33879	27.4	44956	27.7	32.7	56701	26.9	26.1	62900	26.8	10.9
Hem.	20843	16.9	27435	16.9	31.6	30062	14.3	9.6	33993	14.5	13.1
Blood Bk	10189	8.2	17214	10.6	68.9	25336	12.0	47.2	27043	11.5	6.7
Histo.	10732	8.7	13203	8.1	23.0	14753	7.0	11.7	20385	8.7	38.2
Cytology	4676	3.8	7294	4.5	56.0	9792	4.7	34.2	10935	4.7	11.7
Microbi.	23795	19.3	21471	13.2	-9.8	32305	15.4	50.5	38657	16.5	19.7
Services	2312	1.9	3539	2.2	53.0	0	0	-	0	0	-
Procure.	9495	7.7	15578	9.6	64.1	25444	12.1	63.3	27249	11.6	7.1
Other	6339	5.1	9678	6.0	52.7	12747	6.1	31.7	13729	5.8	7.7
TOTAL	123536	100	162115	100	31.2	210421	100	29.8	234894	100	11.6

units = workload units
% T = percent of total laboratory workload for that period.
% C = percent changed from previous period.
Chem. = Chemistry, Hem. = Hematology, Blood Bank = Blood Bank,
Histo. = Histology, Microbi. = Microbiology, Procure. = Procurement

On examination of data aggregated by hospital size groups, it is apparent that there are subtle differences between each size group, with some services experiencing varying degrees of change over time (see Appendix 6). Generally, the proportion of workload attributable to a particular laboratory service has remained relatively constant over time with only a few notable exceptions. The proportion of Chemistry workload in teaching hospitals has decreased steadily over time from 32.3% in 1970 to 26.6% in 1980 while that of other size groups has remained relatively constant. The general trends mentioned above for Blood Banking and Procurements appear consistent throughout all size groups. The modest general decrease in the proportion of Microbiology mentioned above is less consistent with the largest decreases occurring in the teaching hospitals and relative stability in the other hospital size groups.

The increased activity in Blood Banking is likely due to increased surgical activity in some hospitals and changes in Blood Banking procedures which have not been reflected in new unit values. Unit values for Blood Banking procedures have remained relatively unchanged over the years and are only now being reviewed. New Blood Banking unit values to be implemented in 1985 will result in decreases of more than 50% in many cases. The recently revised unit values in Hematology and Chemistry implemented in 1983 caused reductions in the order of 20% and 40% respectively in certain cases. The small incremental changes made over the years were primarily in hematology and chemistry and were largely in response to automation. It may be that the apparent increase in the proportion of Blood Banking is merely the result of increasingly distorted values of the measurement units for this discipline. Certainly, increased surgical activity as determined by the amount of work flowing through Histology does not appear to have changed significantly in relation to overall laboratory workload during the study period when all hospitals are considered collectively.

The increased prominence of Procurements is likely due to two factors. The number of patient days has increased over the study period and hence, it should be expected that the number of specimens collected should also increase. Because the efficiency of specimen collection has not yet been dramatically affected by automation, the unit values have remained relatively unchanged over the years. Over the same time period, unit values for automated tests have decreased so that while the number of tests resulted has increased, the unit value has decreased. It should, therefore, be expected that the proportion of the workload attributable to specimen collection will increase under these conditions. This increase in procurements could also be a reflection of the increased intensity of laboratory testing per patient.

The evidence that the proportion of laboratory workload attributable to Chemistry is decreasing in teaching hospitals is likely indicative of increased automation in this service or perhaps, increased use of private laboratories. The workload volume in the large teaching hospitals can support large automated equipment which may not be cost justified in smaller hospitals. Such large volume, multifunction analyzers generally have a lower unit value than smaller, less automated analyzers. This apparent trend in Chemistry may also be attributable to efforts in a teaching environment to reduce the volume of unnecessary tests and to demonstrate to medical students the responsible use of laboratory services. There have been several reports in the literature regarding successful efforts to control the unnecessary use of laboratory tests.(39)

A review of the percentage of total laboratory workload comprised of inpatient and outpatient workload shows that generally, the proportion of hospital laboratory workload attributable to outpatients has been increasing from 1970 to 1980 in essentially all hospital size groups. The exception was a substantial decline in outpatient work in Group I hospitals between 1970 and 1974. It is interesting to note that the volume of outpatient work decreases as hospital sizes increase. This may be a reflection of the lack of private laboratories in smaller communities providing services to ambulatory patients so the hospitals have assumed this function to a larger degree than they might have had there been competition from the private sector.

Laboratory Workload and Hospital Activity Comparisons

To obtain a more accurate picture of how laboratory workloads have changed in each size group, laboratory units are related to Patient Days and Acute Care Admissions. Both of these calculations provide a measure of the intensity of laboratory testing in the reporting hospitals.

While the number of patient days and acute care admissions are accurate within the limitations of the reporting practices of the hospitals, the laboratory workload reported cannot be divided into acute care patient workload and long term patient workload due to the reporting requirements of the HS-1 returns. Such a breakdown is not requested on these returns. It was assumed for the purposes of this study that the proportion of total laboratory workload attributable to long term care patients in predominantly acute care institutions is miniscule in relation to total workload and will not significantly affect the above mentioned calculations.

Appendix 7 summarizes the total laboratory workload for all hospital size groups as well as summarizing the laboratory workload directly attributable to inpatients, outpatients, referred-in specimens, and quality control workload. Table XI presents the number of inpatient laboratory workload units per patient day and Table XII presents the number of laboratory workload units per acute care admission.

The measure of inpatient laboratory workload used in these tables include units from quality control work related to the performance of inpatient tests. The quantity of quality control work performed in a laboratory is related to the volume of patient workload, however, the format of recording quality control precludes its division according to its relation to inpatient or outpatient workloads. For the purpose of these tables, quality control workload was divided proportionately between inpatient, outpatient, and referred-in, and then added to that component of workload. The proportions are recorded in Appendix 7. It should therefore be understood that the data presented in Tables XI and XII do not represent the exact volume of laboratory workload directly attributable to inpatients, but does provide a reasonable estimate on which to base comparisons between reporting years and hospital size groups.

TABLE XI
Inpatient Laboratory Workload Units per Patient Day and Percentage Change Between Periods, by Hospital Size Group, 1970 - 1980

Hospital Size Group	1970	1974		1978		1980		1970-1980
	units	units	%	units	%	units	%	%
Group I	14.1	20.9	48.2	28.7	37.3	32.3	12.5	+129.0
Group II	20.0	27.7	38.5	30.7	10.8	31.5	2.6	+57.5
Group III	22.7	30.6	34.8	29.6	-3.3	30.2	2.0	+33.0
Group IV	28.5	34.0	19.3	39.5	16.2	40.9	3.5	+43.5
Group V	43.7	45.8	4.8	63.5	38.6	73.8	16.2	+68.9
TOTAL	25.2	30.8	22.2	38.4	24.6	41.1	7.0	+63.0

units = inpatient laboratory workload units per patient day
% = percent change from previous period.

As is readily apparent, there have been considerable increases in both measures between all reporting years for most hospital size groups. This finding is consistent with what was expected based on reports in the literature regarding increased use of laboratory services.(40,41,85) By looking at the rate of increase between reporting years it is clear that following very large increases in the early 1970's the trend is towards much smaller increases, and in some cases decreases, by the end of that decade. It will also be noticed that, generally, the smaller hospitals experienced the largest increases in both measures.

Laboratory Workload Per Patient Day

The net increases in the laboratory workload per patient day ranged from a high of 129.0% for Group I hospitals from 1970 to 1980, to a low of 33.0% for Group III hospitals over the same period. This could be an indication that physicians practicing in centres with very small hospitals have come to rely more heavily on laboratory screening to support their diagnoses. It could also be an effect of increased automation allowing small hospital laboratories to perform many tests previously referred to larger laboratories or simply not ordered. Such improvements in automation may be allowing smaller laboratories to fill a latent demand for laboratory testing. Present multi-parameter analyzers come in various sizes, at various costs, with almost certainly an appropriate machine to fit most needs and cost considerations. This trend could also be a reflection of increased outpatient activity in the smaller centers.

There is definitely a move towards more ambulatory services offered out of hospitals including laboratory services and, as will be noted from Appendix 7, the percentage of out-patient workload was consistently higher in the smaller hospitals and generally increased throughout the study period. There is more competition in the larger centres between hospital and private laboratories so that increased laboratory work in total would not affect such hospitals as much as the same trend in a location without laboratory competition. The trend is probably due to a combination of all three of the above factors, and possibly others.

It is of interest to note that the rate of increase in laboratory workload per patient day appears to be slowing overall, but is particularly noticeable in the smaller hospitals which experienced very large increases between 1970 and 1974. Interestingly, the teaching hospitals of Group V experienced the reverse trend. It should be noted that this time period corresponds to the period when the N.D.P. was in power in British Columbia. The N.D.P. campaigned on the issue of the Social Credit ignoring social programs including health care arguing that they were in desparate need of an infusion of money. It would be interesting to review capital equipment expenditures for laboratories for the period 1970 to 1980 to see if there was more equipment purchased in the 1970 to 1974 period than during the remainder of the decade. If such were the case, it would tend to strengthen the link between the capacity to perform a test (supply) and the demand for that test. Unfortunately, such information was not available when requested of the Ministry of Health.

The slowing rate of increase in laboratory workload per patient day may also be indicative of successful restraint measures to reduce laboratory utilization, particularly through physician education. It may also be that the latent demand generated by improved access to laboratory tests has peaked.

As would be anticipated, based on the likely acuity of patients seen in the hospitals of various size groups, the actual volume of laboratory workload per patient day generally increased with hospital size.

Laboratory Workload Per Acute Care Admission

Data related to the volume of laboratory workload per acute care admission shows similarities to that of workload per patient day. Again, the highest volume of laboratory workload per acute care admission, (ACA), occurred in the teaching hospitals and progressively decreased to the lowest level in the hospitals of Group 1. It was also found that the rate of increase in laboratory workload per admission is slowing and, in some cases, even declining.

TABLE XII
Inpatient Laboratory Workload Units per Acute Care Admission and Percentage Change Between Periods, by Hospital Size Group, 1970 - 1980

Hospital Size Group	1970 units	1974 units	1974 %	1978 units	1978 %	1980 units	1980 %	1970-1980 %
Group I	104.2	142.6	36.9	179.1	25.6	190.9	6.6	+83.2
Group II	169.0	209.1	23.7	243.9	16.6	277.2	13.7	+64.0
Group III	178.7	245.9	37.6	322.6	31.2	236.1	-26.8	+32.1
Group IV	308.4	303.1	-1.7	506.7	67.2	518.2	2.3	+68.0
Group V	447.5	442.8	-1.1	916.3	106.9	729.2	-20.4	+62.9
TOTAL	225.0	251.4	11.7	380.3	51.2	368.7	-3.0	+63.0

units = inpatient laboratory workload units per acute care admission
% = percent change from previous period.

It was interesting to note that the total percentage increase from 1970 to 1980 was very similar for all hospital size groups, with the exception of Groups I and III with Group I experiencing a larger than average increase and Group III experiencing a lower than average increase in laboratory workload per acute care admission. This would suggest that changes that have led to increased laboratory testing in hospitals have, for the most part, been general changes affecting all physicians and hospitals and not something that can be related to a particular group of hospitals or physicians.

There has been considerable speculation on which factors contribute to the growing use of laboratory testing. Griner suggests that overuse stems from concern over missing unsuspected diagnoses or unexpected changes in the patient's clinical condition, medico-legal considerations, innate curiosity and, in some situations, the need to "work up" a patient completely to satisfy one's peers or supervisory physicians.(86)

As the primary generators of laboratory demand, physicians have been the subject of efforts to control the mis-use of laboratory tests. It is often suggested that the percentage of laboratory studies that directly affect patient management is low.(56,87) Most efforts to control the over-use of laboratory tests have been directed toward educating the physician on appropriate test ordering habits, the costs of tests, and the limitations of certain laboratory procedures.(39,40,86,87) These efforts have met with varying degrees of success but efforts continue to find even more control mechanisms to ensure the most cost-effective and cost-beneficial use of laboratory services.

LABORATORY OPERATING COSTS IN BRITISH COLUMBIA HOSPITALS

Categories of information related to laboratory operating costs include: Medical Salaries; Non-Medical Salaries; and Supplies and Expenses. Medical Salaries include all salaries and fees paid to full-time, part-time, sessional, and fee-for-service physicians employed by the hospital for the operation of the laboratory. Non-Medical Salaries include all salaries paid to technical, clerical, and administrative personnel employed in the laboratory. Supplies and Expenses includes all other laboratory operating expenses excluding medical and surgical supplies and drugs. This category includes purchased services from outside laboratories, radioactive material, and such laboratory supplies as glassware, plastics and chemical reagents.(1)

These costs are presented in Appendix 8 for each hospital size category. The figures for all hospitals combined are presented here in Table XIII. All figures have been adjusted for inflation, except as noted, and are reported in 1971 dollars. The schedule of inflation used was as reported by Statistics Canada for all of Canada.(4) The year 1971 was chosen as base year as it is the year most commonly used in all government reports where there are adjustments for inflation. These Tables also demonstrate how the proportion of each expense category changed over time and between hospital size groups. These figures do not consider changes in the number of beds in each hospital size group between reporting periods.

TABLE XIII
Laboratory Operating Expenses by Category of Expense Showing Percentage Distribution and Percentage Change Between Periods, 1966 - 1980

Exp. Cat. *	1966 $ x1000	1966 % T	1970 $ x1000	1970 % T	1970 % C	1974 $ x1000	1974 % T	1974 % C	1978 $ x1000	1978 % T	1978 % C	1980 $ x1000	1980 % T	1980 % C	1966 1980 %
Med. Sal.	1021	16	2262	18	122	3107	16	37	3843	13	23	4669	14	22	+357
Oth. Sal.	3679	56	8045	62	119	12364	62	54	17632	62	43	19759	60	12	+437
S&E	1815	28	2618	20	42	4488	22	71	7164	25	60	8633	26	21	+376
TOT.	6515	100	12925	100	98	19959	100	54	28640	100	44	33061	100	15	+407

% T = Percent of total expenses for that period rounded to the nearest whole number to conserve space.
% C = Percent change from the previous period rounded to the nearest whole number to conserve space.
Exp. Cat. = Expense Category
Med. Sal. = Medical Salaries
Oth. Sal. = Other Salaries
S&E = Supplies and Expenses
* All cost figures are adjusted for inflation by presenting in 1971 dollars.

Non-Medical Salaries

The largest portion of laboratory costs is attributable to non-medical salaries. Typically, this expense accounts for approximately 60% of the total laboratory budget. This ratio has not changed dramatically over the study period for most hospital size categories. Group I and Group V hospitals experienced the most activity in this regard with Group I non-medical salaries ranging from 55.1% to 67.1% of the total and Group V non-medical salaries ranging from 54.9% to 71.0% of the total operating costs.

The rate of growth between reporting years for this item is clearly slowing for all hospitals, in aggregate, and for each individual size group. Overall, the rate of increase has slowed from 118.7% between 1966 and 1970 to 12.1% between 1978 and 1980. Even considering the two year spread between 1978 and 1980, the trend is still clearly towards a much slower rate of growth. This trend is consistent for all hospital size groups, but perhaps to a lesser extent in Group V hospitals. A further note regarding non-medical salaries is that this expense item realized the largest increase from 1966 to 1980 at 437%, compared to increases of 357% and 376% for medical salaries and supplies and expenses respectively.

Supplies and Expenses

The second largest portion of the laboratory operating budget is supplies and expenses. This comprises something of the order of 24% of the overall budget and has been increasing slowly but steadily since 1970, from 20.3% to 26.1% in 1980. The percentage increases between each reporting period have been consistently large and do not demonstrate any clear trends towards an increasing or decreasing rate of growth. When data from the individual hospital size groups are examined, there are apparent diffences in the prominence of this expense item in relation to the other two expense categories. Typically, supplies and expenses account for a larger portion of the overall budget in smaller hospitals. Any trends regarding direction or rate of growth are less clear for each size group. However, it should be noted that the percentage increases between reporting years are much larger for non-medical salaries than for supplies and expenses in the smaller hospitals while the reverse is true in the larger hospitals.

Medical Salaries

Medical Salaries typically comprise the smallest proportion of the overall budget, averaging approximately 15% for all hospitals, and do not demonstrate any clear trends with regards to direction or rate of growth. This is consistent for each hospital size group.

It will be noted that there is a very clear difference in the proportion of medical salaries for laboratory work as a component of the overall laboratory budget in hospitals of the various size groups. Medical salaries comprise approximately 6% of the laboratory budget in hospitals of less than 100 beds but approximately 20% of the laboratory budget in hospitals with more than 300 beds, which is only slightly higher than for teaching hospitals at 19%.

This is obviously an indication of the level of laboratory physician coverage in small rural hospitals where, commonly, a single general pathologist provides coverage for several hospitals. Interestingly, it is not the teaching hospitals that expend the largest proportion of their budgets on medical salaries, but the largely regional referral hospitals of Group IV. Among the factors contributing to this situation is the role of the University of B.C. in partially supporting the salaries of some laboratory physicians in teaching hospitals. Another major factor is that the salaries of laboratory physicians in teaching hospitals is substantially below those of non-teaching hospitals. This is in large part attributable to a different set of aims and goals of pathologists and laboratory physicians in the teaching hospitals as compared to their collegues in the non-teaching hospitals.

One must be cautious when relating medical salaries to laboratory workloads or when making comparisons between hospitals in terms of laboratory medical salaries. In addition to the limitations identified above, some hospitals have developed unique arrangements for laboratory services and laboratory physician consultation. One large regional hospital refers much of its laboratory workload to a private laboratory built adjacent to the hospital. The medical staff of the private laboratory provide a consulting service to the hospital. Therefore, fees paid to laboratory medical staff will be recorded on the HS-1 Return, but laboratory workload performed in the private laboratory will not be recorded in terms of workload units but likely as an operating expense. This gives the impression that the hospital has a much lower rate of laboratory workload per patient day or acute care admission than it actually has. It would also appear to have an inordinately large volume of consulting fees in relation to the volume of laboratory work performed in the hospital.

Another large regional hospital has its laboratory workload performed in its own laboratory but laboratory medical fees are paid to a group of laboratory physicians and pathologists organized to operate the hospital's laboratory on a contractual basis and not as hosptial employees as is most common.

In depth and meaningful comparisons of laboratory services between hospitals would certainly be enhanced by increasing the uniformity of the organization and operation of hospital laboratories throughout the province.

Laboratory Costs Per Hospital Activity Indicator

A clearer picture of what is actually happening to laboratory costs in each hospital size group may be found by standardizing costs to acute care admissions, patient days, and laboratory workloads units. These parameters are demonstrated in Tables XIV, XV, and XVI, all of which are also presented in constant 1971 dollars.

The laboratory cost per patient day as presented in Table XIV has essentially increased between all reporting periods and for all hospital size groups. Collectively, costs per patient day have increased from $2.72 in 1966 to $6.02 in 1980 in 1971 dollars. The highest cost per patient day occurs in the teaching hospitals and generally decreases with hospital size. The rate of increase for all hospital size groups is clearly slowing which may be attributable to improved cost efficiencies through increased automation as well as efforts to control the volume of laboratory work ordered on each patient.

Laboratory cost per acute care admission follows a similar pattern to that described above. As was expected, the costs per acute care admission were found to increase with hospital size. The rate of increase between reporting years is less consistent than for costs per patient day and while no clear trends have emerged, it would appear that there is a general slowing in the rate of increase in costs per acute care admission.

TABLE XIV
Laboratory Costs Per Patient Day and Percent Change From Previous Period, by Hospital Size Group, 1970 - 1980

Hospital Size Group	1970	1974		1978		1980		1970-1980
	$	$	%	$	%	$	%	%
Group I	1.67	2.47	47.9	3.86	56.2	4.42	14.5	+165.6
Group II	2.21	3.24	46.6	4.09	26.2	4.05	-0.9	+83.2
Group III	2.72	3.57	31.2	4.20	17.6	4.41	5.0	+62.1
Group IV	2.95	4.44	50.5	5.71	28.6	6.06	6.1	+105.4
Group V	4.03	5.76	42.9	8.19	42.1	10.52	28.4	+161.0
TOTAL	2.72	3.96	45.5	5.44	37.3	6.02	10.6	+121.3

$ = Laboratory costs per patient day
% = Percentage change from previous period.
All cost figures adjusted for inflation by reporting in 1971 dollars.

Laboratory costs per workload unit have increased at a much slower rate than the other two parameters described above. During the study period from 1970 to 1980, Group V hospitals experienced the largest increase from $0.092 in 1970 to $0.141 in 1980 representing an increase of 54.6%. Group I hospitals reported the lowest net increase at 15.2%; increasing from $0.119/unit in 1970 to $0.137/unit in 1980.

TABLE XV
Laboratory Costs Per Acute Care Admission and Percentage Change From Previous Period, by Hospital Size Group, 1970 - 1980

Hospital Size Group	1970	1974		1978		1980		1970-1980
	$	$	%	$	%	$	%	%
Group I	12.38	16.87	36.2	24.13	43.0	26.13	8.2	+111.0
Group II	18.64	24.43	31.0	32.50	33.0	37.71	16.0	+102.3
Group III	21.48	28.64	33.3	45.77	59.8	34.44	-24.7	+60.3
Group IV	31.89	39.61	24.2	73.27	84.9	76.84	4.8	+141.0
Group V	41.21	55.76	35.3	118.31	112.1	103.87	-12.2	+152.1
TOTAL	24.31	32.39	33.2	53.83	66.1	54.06	-0.4	+122.4

$ = Laboratory costs per acute care admission.
% = Percentage change from previous period.
All cost figures adjusted for inflation by reporting in 1971 dollars.

In terms of actual unit cost, the figures are remarkably similar, with seldom more than one to two cents per unit difference between the highest and the lowest value. Generally Group IV hospitals had the highest cost per unit and Group II the lowest. The relationship between Group I hospitals and Group V hospitals noted above does not appear to apply in this measurement. The rate of change between reporting years varies considerably between size groups and makes identfication of trends difficult, although it may be suggested that the rate of increase is generally slowing. This is particularly clear for Group IV hospitals. As salaries have increased substantially over the study period, this slower rate of increase in laboratory costs per unit must be attributable to higher productivity largely through increased automation.

TABLE XVI
Laboratory Expenses Per Laboratory Workload Unit and Percentage Change Between Periods, by Hospital Size Group, 1970 - 1980

Hospital Size Group	1970	1974		1978		1980		1970-1980
	$	$	%	$	%	$	%	%
Group I	0.119	0.118	-0.3	0.135	13.8	0.137	1.6	+15.2
Group II	0.110	0.117	5.9	0.133	14.0	0.129	-3.3	+16.8
Group III	0.120	0.116	-3.0	0.141	21.8	0.146	2.8	+21.5
Group IV	0.103	0.131	26.4	0.145	10.6	0.148	2.6	+43.5
Group V	0.092	0.126	36.7	0.129	2.5	0.142	10.1	+54.6
TOTAL	0.105	0.123	17.7	0.136	10.6	0.141	3.4	+35.5

$ = Cost per workload unit (in 1971 dollars).
% = Percentage change from previous period.

SUMMARY

It was expected that the proportion of technical assistants employed in laboratories would increase with automation and cost-efficiency efforts. Such was not the case in B.C. hospitals. This was attributed largely to a lack of qualified technical assistants in the market-place, union territorial protection, and the desire to maintain the flexibility of using skilled technologists.

Another expectation that did not materialize was a more pronounced stratification in the ranks of medical laboratory technologists. Although the reliability of some of the data is in question, it would appear that, essentially, there has been no change in this regard throughout this study period.

The only aspect of the findings, related to laboratory personnel, that approached the expected outcomes was that the growth in the workforce is not progressing as quickly as the growth in laboratory workload. Laboratory workload increased by about 90% from 1970 to 1980 whereas total laboratory personnel, excluding medical staff, increased by 65.8% over the same period. This is among the expected results of automation. In terms of workload units per FTE, the amount of work each employee can process per year has continually increased, thanks primarily to increased and improved automation.

It has been reported in the literature that automation does have a significant impact on both laboratory productivity and laboratory operating costs. In British Columbia, between 1970 and 1980, workload in hospital laboratories increased by 90%. There was little change in the distribution of the workload between laboratory services, with the exception that Blood Banking and Procurements increased in proportion to other service areas. This was attributed to increased surgical procedures and increased intensity of laboratory testing reflected in more specimens collected. Chemistry, in the teaching hospitals, accounted for an increasingly smaller proportion of total workload units. This was attributed to advancements in automation and to efforts to control use of laboratory services through education and other means.

Laboratory workload per patient day and per acute care admission increased for all hospital size groups throughout the study period, reflecting increased utilization of laboratory services. Smaller hospitals generally experienced the largest increases in this regard, perhaps reflecting a fulfilment of a latent demand for laboratory services, satisfied by improvements in automated equipment in regards to size and cost. Generally, increases in laboratory workload per patient day are slowing; perhaps an indication of successful restraint measures or a satisfaction of latent demands.

As was expected, data on laboratory operating costs show those costs to be increasing in real terms by an average 14% per annum for the period 1970-1980. The most rapid growth appears to have occurred during the early 1970's with subsequent smaller increases up to 1980. Salaries led the increases in the early part of the study period, particularly from 1966 to 1970 while Supplies and Expenses were increasing at a faster rate by the end of the study period.

This trend is clearly what one would expect to see arising from improved laboratory efficiency through increased automation; that is, increased consumables cost and decreased labour cost. As a percentage of overall laboratory expenses, both medical and non-medical salaries decreased continually throughout the study period while the percentage of total expenses attributable to supplies steadily increased.

CHAPTER IX

SUMMARY AND CONCLUSIONS

The objective of this study was to review laboratory utilization in public hospitals in British Columbia and to analyze trends in their utilization, in relation to the future development of laboratories and the impact of these trends on manpower deployment and planning. The study encompassed the period from 1966 to 1980 and trends were identified by examining data for each of 1966, 1970, 1974, and 1980. The primary source of laboratory utilization data were the HS-1 statistical returns prepared annually by all hospitals.

The study addresses four main areas that impact on, or are affected by, the utilization of laboratory services. Data related to these impact areas were analyzed in terms of their effect on either the demand for laboratory services or the supply of laboratory services in British Columbia. Data collected were related to the effect of changing demographics, changes in technology and automation, changes in the supply of physicians, and changes in the supply and mix of laboratory manpower.

There were occasions when data reported in the HS-1 returns appeared to be inconsistent with other findings and generally improbable. This is likely the result of clerical error or misinterpretation of the instructions and definitions for completing these statistical returns. In such situations, the inconsistencies were pointed out and the item in question omitted from the analysis. It would be beneficial to all users of these data if the instructions and definitions provided to complete the HS-1 and HS-2 returns were clarified to avoid any confusion and misinterpretation on the part of the people completing the forms.

At the outset of this study it was hoped that data related to capital equipment acquisition would be available in order to relate changes in this regard to laboratory workloads, laboratory costs, and laboratory staffing. When it was found that such information was not readily available from the Ministry of Health, these relationships could only be the subject of conjecture. It would be an interesting future undertaking to review the availability of automated equipment and its relation to changes in the demand for laboratory services.

Background

From an initial review of the development of British Columbia's health care delivery system, it was found that our present province-wide medical and hospital insurance system had its beginning in a 1919 B.C. Royal Commission on state health insurance. Following further Royal Commissions, initial legislation, and growing dissatisfaction with the private insurance plans, B.C. introduced the Hospital Insurance Act in 1949. While this hospital insurance plan was universal in application, it excluded chronic care and outpatient services. This approach meant it was less of a financial burden to patients to have certain health care services provided on a hospital inpatient basis and hence, focused B.C.´s utilization of health care services around hospital care.

At approximately the same time, the federal government introduced its National Health Grants Act (1948) which provided a source of funds to provinces covering 50% of the capital costs of hospital construction. Communities then had a source of funds to build their own hospitals, and through the Hospital Insurance Act, a source of guaranteed payment to operate them, The outcome was a proliferation of new or renovated hospitals throughout the province during the 1950´s and 1960´s.

The consulting firm of James Hamilton and Associates was hired by the B.C. government in 1949 to prepare a provincial hospital construction and manpower plan. Out of that study came recommendations for more hospital beds, enlargement of the province´s health manpower training facilities, and the adoption of a regional hospital plan with an organized referral pattern. It was from this base that the province´s existing regional hospital system developed. This regionalization concept was further developed by the subsequent establishment in 1967 of Regional Hospital Districts.

Insured health care services were expanded to include physician services in 1965 with the introduction of the Medical Grant Act in B.C. followed by the federal government's Medical Care Act in 1968. The B.C. Medical Grant Act was based on a fee-for-service payment system and allowed physicians a role in setting the fee schedule. The federal Medical Care Act required the federal government to pay 50% of all insured medical services.

The impact of these developments on laboratories was an increase in laboratory workload because of the increased opportunities presented in the new facilities to provide laboratory services, the removal of financial barriers, and the increased importance which laboratory procedures played in the diagnosis and treatment of patients. There was a period of rapid, uncoordinated laboratory expansion which resulted in considerable duplication of expensive procedures. This drew the attention of the provincial government which initiated a regional referral system for laboratory services similar to that intended for hospital services in general.

Later efforts to coordinate and rationalize the delivery system, as it relates to laboratories and hospitals, included the various planning efforts of the B.C. Medical Center, the Bed Matrix study, the Joint Funding study and the Hospital Role study. All of these efforts have had some degree of impact on the health care delivery system if only to bring attention to the need for more cost-effective organization and management of the system. Efforts are continuing today to bring more rational planning and accountability into the system.

Growth in the Demand for Health Care Services

A number of factors have been identified as contributing to the growing demand for laboratory services. Among these factors are included an increasing and aging population accustomed to a high level of quality health care services; a growing supply of physicians, each of whom wish to provide their patients with the best care possible and who also wish to maintain a high standard of living; and the ability to meet the demand easily and increasingly efficiently through increased and improved automated equipment.

It was found that B.C.'s population increased by approximately 41% from 1966 to 1980 and that the increase was predominantly due to in-migration from other provinces. It was also noted that the elderly tend to use a disproportionately large amount of health care services and the the population of B.C. and the rest of Canada is aging. The percentage of the population in Canada over the age of 65 increased from 5.1% in 1901 to an estimated 9.5% by 1981. The percentage of the population over the age of 65 in B.C. increased by a full percentage point to 10.9% between 1976 and 1981.

The changes in demographics and funding of health facilities are reflected in changes in the number, mix, and utilization of institutional beds. It was found that, overall, the number of hospital beds in B.C. increased in proportion to the population from 15.2/1000 in 1962 to 17.6/1000 in 1978. The distribution of these beds by function also changed, with acute care beds decreasing from 6.1/1000 to 4.3/1000 for the same period and long term care beds increasing from 0.4/1000 to 2.2/1000 also for the same period.

In addition to the changing number of beds, there were also changes in the distribution of these beds by hospital service. It was found that generally, there were increases in the proportion of Intensive Care beds and Psychiatric beds and decreases in the proportion of Obstetrical and Pediatric beds. The exception to this general trend was the finding that the proportion of Obstetrical and Pediatric beds in the referral hospitals of Group IV increased substantially throughout this study period. It was suggested that this reflected a move towards centralization of these rather specialized beds

As would be expected from the increased population and the growing supply of hospital beds in B.C., it was found that the use of hospital facilities increased in terms of Patient Days and Acute Care Admissions. More significantly, it was found that the available facilities appear to be used more closely to their capacity with general increases in the number of patient days per acute care bed for all hospital size groups except for Group V which experienced a decrease of 11%. In addition, it was found that there was an overall modest increase in the number of admissions per bed and a more substantial increase in the average length of stay. It was interesting to note that while Group I hospitals had a very large increase in the average length of stay, the hospitals of Groups IV and V had quite substantial decreases in this measure. This was attributed to restraint efforts and increased use of ambulatory services in the larger hospitals.

The increased inpatient activity in hospitals, hospitals' increased role in the provision of outpatient services, and the increased amount of laboratory work ordered by the physician population, have all contributed to the growth in the demand for laboratory services.

With regard to the impact of the supply of physicians on laboratory utilization, it was found that many researchers identify physicians as having the single most important role in the delivery of health care services because their decisions and behaviour affect almost all aspects of the delivery system. It was noted that several authors have suggested that a physician's place of training and his or her personality are key factors in determining how a physician uses laboratory services. It has been these areas that have recieved considerable attention in efforts to control the utilization of laboratory services and some successes of varying degree were reported.

The implication of these increases in the demand for laboratory services on laboratory manpower is to increase the demand for laboratory manpower resources. In addition to merely considering the growth in the demand for medical technologists in terms of B.C.'s ability to recruit trained personnel or its desire, or obligation, to increase the training facilities for local residents, health manpower planners must also consider the appropriateness of the current emphasis on medical laboratory technologists and whether policy changes may be imminent that would impact the type of personnel laboratories employ.

Issues Related to the Supply of Health Care Services

This study included a review of the current patterns of manpower deployment in B.C. hospital laboratories. The development of medical laboratory technologists as an organized group of para-medical professionals was reviewed from their early days of on-the-job training to become assistants to pathologists, to the current extensive training programs and multiple levels of certification and registration.

The study goes on to describe issues relevant to manpower planning and the historical development and organization of manpower planning in B.C. from the Hamilton Report of 1949 to the Western Canada Health Manpower Training Study of 1982. It was noted that B.C. has traditionally been, and continues to be, a net importer of trained health care manpower and the possible implications of this were discussed.

Findings and Implications

One of the expectations of this study was the prospect of finding evidence of increasing technical stratification in the laboratory workforce due largely to the impact of automation on career paths and hospital expectations for cost-effective operation. It was believed at the outset of this study that increasing automation would simplify many aspects of the day-to-day workflow in laboratories, leading to a reduction in the need for such highly trained personnel as medical laboratory technologists and an increasing demand for technical assistants. It was also expected that there would be an increasing proportion of A.R.T.s and Licentiates among Registered Technologists, as technologists use these additional qualifications to advance themselves in their professions and careers. If such trends are indeed an effect of automation as suggested in the literature, this concept could not be supported by evidence presented in this study. However, rather than ruling out this effect, it should be considered that the study period may have been too short for the effect to be manifested and perhaps a study covering a wider time period should be undertaken.

It was found that the percentage distribution of the various laboratory personnel groups changed only slightly over the study period with the proportion of Registered Technologists increasing slightly, the proportion of Technical Assistants increasing even more modestly,and the proportion of Laboratory Scientists decreasing slightly. The proportion of clerical staff remained essentially unchanged throughout the study period.

It was also found that overall, there was very little change in the distribution of A.R.T.´s, Licentiates, and R.T.´s although it was noted that in hospital size Groups I, II, and III, their numbers were increasing, while the reverse was true for hospitals of Group IV and V.

Data related to actual laboratory workload were collected for each hospital size group. As expected, the volume of laboratory work increased throughout the study period for all hospital size groups and by all measures including workload per patient day and workload per acute care admission. It was interesting to note that the smaller hospitals of Group I experienced the largest increase in laboratory workload per patient day, possibly reflecting the applicability of current automated equipment to small laboratories allowing them to satisfy a latent demand. It was also interesting to note that contrary to what may have been expected, based on reports in the literature, the amount of laboratory work per admission in teaching hospitals in B.C. is not increasing at a faster rate than in non-teaching hospitals.

Another expected effect of automation on laboratories was related to laboratory operating expenses. This study shows that the proportion of the overall laboratory operating budget allocated to operating supplies is increasing steadily while the proportion attributable to technical salaries is remaining relatively constant and that of medical salaries appears to be decreasing.

It was demonstrated that the volume of laboratory work being processed in B.C. public hospitals has been increasing throughout this study period. This was demonstrated in terms of total laboratory workload reported, as well as in terms of laboratory workload per patient day and per acute care admission. A factor that could not be analyzed in this study was the change in the number of laboratory tests per patient day or acute care admission. The test count is not reported by hospitals to the Ministry of Health except for tests referred out. The number of tests per patient day or acute care admission would likely show a greater increase than the laboratory workload units per patient day or acute care admission as the necessary workload units to complete a test are substantially moderated by increasing automation.

Discussion

A number of paradoxical situations have been described that relate to various aspects of laboratory operation and staffing. It was noted that the use of technical assistants is more prevalent in some hospitals then others and that their use could contribute to a more cost-effective operation, yet B.C. does not have a laboratory assistant training program and must rely on recruiting from out of province or on-the-job training.

Reasons for the absence of such a training program have been discussed in this study and include fear of wage differential struggles between technical assistants and technologists, such as had developed between registered nurses and practical nurses; union protectionism preserving a share of the marketplace for their members; the question of whether to include a clinical training period and who would pay for it; and the unwritten policy that requires B.C. to import trained personnel as long as it is able to do so. If B.C. hospital laboratories are to become as cost-efficient in their operation as possible, it will be necessary to have a better distribution of highly trained and lesser trained personnel. This will require changes in the way B.C. currently uses laboratory technical assistants.

Related to the use of laboratory assistants is the supply of medical laboratory technologists. It was reported that one study projected a need for an additional 40 medical laboratory technologist graduates per year, over and above the current level of graduates, until the turn of the century. At the present time, B.C.´s technologist training institutions are having to reduce their enrollments because, in part, hospitals are reducing the number of positions available for third year clinical practicums. The problem is largely one of financing which has the Ministry of Health funding post-secondary education in that hospitals pay their student technologists a minimum wage. Because of general financial constraints some hospitals are trading in their student positions for fully qualified bench technologists. If this trend continues, B.C. will find itself more dependent on out-of-province manpower which could lead to eventual manpower shortages not to mention domestic unrest. A speedy solution should be sought for this present situation before it becomes a major problem.

Another possible conflict related to the overall laboratory services delivery system that should be addressed is the role of the private laboratories in providing laboratory services. Private laboratories are offering services that could be provided by public hospitals without the substantial profit margin built into the payment system being incurred. At a time when wholesale cuts are being considered in many social programs the government must be considering whether it can afford to continue to support the private sector in heatlh care as it relates to laboratory services.

This must be an issue of major philosophical conflict for the present Social Credit government that prides itself on its support of the private sector and small businesses. This conflict may be such that the question is temporarily avoided by government policy makers who may focus their attention towards other options in controlling the use of laboratory services.

There are a number of areas discussed in this study where government either has looked, or could look for ways of controlling laboratory utilization. Modifying how a physician makes use of laboratory services is an area receiving considerable attention because it is the physician's actions that in large part drive the demand for such services. Initial studies by Hardwick, Freeborn, and Schroeder, among others, suggests there may be some successes in this regard.

A less direct method of controlling the use of laboratory services by physicians is controlling the number of physicians. Efforts are only now being made in this direction by limiting Medical Services Plan billing numbers and by not increasing the enrolment of the U.B.C. medical school.

The area in which government influence in controlling laboratory use is most apparent is in financial restrictions on hospitals. Through budgetary constraints on both operating and capital budgets, the government is able to affect indirectly the availability of laboratory services, however, this may actually serve to increase laboratory costs. Hospitals under such constraints may find it necessary to reduce their outpatient workload in favour of inpatient needs and thus force more work towards the private laboratories. At best, this approach can only serve as a stop-gap measure as will any approach based on the cyclical nature of the provincial economy and one that focuses constrictions on the producers rather than the initiators of the demand.

A more rational approach is where the perceived need for laboratory services is changed. This is primarily accomplished through educating the users of laboratory services and through eliminating all financial incentives, both direct and indirect, that promote the use of diagnostic services to ensure that the use of these services is based solely on clinical merit. The B.C. Association of Laboratory Physicians must take a more active role in identifying the appropriate use of laboratory procedures and assisting their peers in proper test selection. Hospital pathologists and laboratory physicians must also become more involved, with the support of hospital administrators, in assuring appropriate test selection by hospital staff and following up and correcting apparent abuses.

It is hoped that the information presented in this study will be of some value to health care planners and policy makers. It is recognized that it is primarily a compilation of data and thoughts rather than an emperical analysis of a problem and a presentation of findings, however, it should serve to generate interest and discussion in some of the areas explored above and may be of some assistance in the continuing efforts to operate the province's health care system in as efficient a manner as possible.

Recommendations

1. Efforts should be made to improve the consistency of data reported by hospitals. Improving the clarity of the Instructions and Definitions for the HS-1 and HS-2 Returns and reviewing the scope of information collected should be of some

assistance in this regard.

2. Private sector laboratories should be required to report their workload activities and staffing patterns to government in the same manner and format as public sector laboratories.

3. The government of B.C. should examine its policies regarding funding of health manpower training facilities and programs to ensure current trends in manpower production will not increase the province's reliance on out-of-province trained personnel.

4. A mechanism should be established to record and monitor the insertion of major capital equipment into the health care system so that these data may be used for future impact studies.

5. Hospitals should be encouraged to make use of alternative manpower resources, where appropriate, to increase operating efficiency and should not be restricted in this regard by organized protectionism.

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APPENDIX 1

TABLE 1 - 1

Number and Percentage Distribution of Hospital Beds by Bed Classification for all B.C. Public Hospitals; by Hospital Size Group: 1966-1980

Group I Hospitals

Bed Classification	1966 Beds	1966 % T	1970 Beds	1970 % T	1974 Beds	1974 % T	1978 Beds	1978 % T	1980 Beds	1980 % T	1966-1980 %
Medical	0	0	273	10.0	221	8.6	434	18.2	504	20.2	-
Surgical	0	0	242	8.9	195	7.6	262	11.0	323	13.0	-
Undistributed Med/Surg. (1)	1,971	63.5	1,403	51.3	1,312	51.2	897	37.6	868	34.8	-56.0
Sub-Total	1,971	63.5	1,918	70.2	1,728	67.4	1,593	66.7	1,695	68.0	-14.0
Intensive Care	12	0.4	12	0.4	44	1.7	39	1.6	46	1.8	+283.3
Obstetrical	436	14.0	324	11.8	300	11.7	312	13.1	319	12.8	-26.8
Pediatric	620	20.0	474	17.3	481	18.8	433	18.1	424	17.0	-31.6
Psychiatric	5	0.2	4	0.1	12	0.5	10	0.4	10	0.4	+100.0
Other	62	2.0	2	0.0	0	0	1	0.0	0	0	-100.0
TOTAL	3,106	100	2,734	100	2,565	100	2,388	100	2,494	100	-19.7

% T = Percentage of total beds for that period.

1966-1980 % = Total percentage increase from 1966 to 1980.

(1) Undistributed beds are those not officially classified as medical or surgical but may be used for either.

APPENDIX 1 (CONT'D)
TABLE 1 - 2
Number and Percentage Distribution of Hospital Beds by Bed Classification for all Public Hospitals; by Hospital Size Group : 1966 - 1980
Group II Hospitals

Bed Classification	1966 Beds	1966 % T	1970 Beds	1970 % T	1974 Beds	1974 % T	1978 Beds	1978 % T	1980 Beds	1980 % T	1966-1980 %
Medical	0	0	639	25.5	539	22.0	506	20.2	479	17.9	-
Surgical	0	0	512	20.4	415	16.9	437	17.4	409	15.3	-
Undistributed Med/Surg. (1)	1,380	65.1	538	21.5	668	27.2	717	28.6	891	33.3	-35.4
Sub-Total	1,380	65.1	1,689	67.5	1,622	66.1	1,660	66.2	1,779	66.6	+28.9
Intensive Care	0	0	53	2.1	71	2.9	90	3.6	97	3.6	+83.0*
Obstetrical	326	15.4	329	13.2	268	10.9	241	9.6	234	8.8	-28.2
Pediatric	373	17.6	367	14.7	373	15.2	349	13.9	337	12.6	-9.7
Psychiatric	18	0.8	63	2.5	121	4.9	132	5.3	184	6.9	+922.2
Other	22	1.0	0	0	0	0	34	1.4	40	1.5	+81.8
Total	2,119	100	2,501	100	2,455	100	2,506	100	2,671	100	+26.1

% T = Percentage of total beds for that year.
1966-1980 % = Total percentage change in the number of from 1966 to 1980.
(1) Undistributed beds
* This percentage change is from 1970 to 1980.

APPENDIX 1 (CONT'D)
TABLE 1 - 3
Number and Percentage Distribution of Hospital Beds by Bed Classification for all B.C. Public Hospitals; by Hospital Size Group : 1966 - 1980
Group III Hospitals

Bed Classification	1966 Beds	1966 % T	1970 Beds	1970 % T	1974 Beds	1974 % T	1978 Beds	1978 % T	1980 Beds	1980 % T	1966-1980 %
Medical	0	0	346	27.4	166	11.0	304	23.7	333	30.7	-
Surgical	0	0	449	35.6	208	13.8	371	28.9	362	33.4	-
Undistributed Med/Surg. (1)	456	63.0	0	0	690	45.8	153	11.9	0	0	-100.0
Sub-Total	456	63.0	795	63.0	1,064	70.6	828	64.5	695	64.1	+52.4
Intensive Care	0	0	29	2.3	36	2.4	48	3.7	39	3.6	+34.5*
Obstetrical	96	13.3	115	9.1	125	8.3	90	7.0	87	8.0	-9.4
Pediatric	149	20.6	216	17.1	195	12.9	134	10.4	100	9.2	-32.9
Psychiatric	23	3.2	29	2.3	87	12.9	87	6.8	67	6.2	+191.3
Other	0	0	78	6.2	0	0	97	7.6	97	8.9	+25.6 *
TOTAL	724	100	1,262	100	1,507	100	1,284	100	1,085	100	+49.9

APPENDIX 1 (CONT'D)

TABLE 1 - 4

Number and Percentage Distribution of Hospital Beds by Bed Classification for all B.C. Public Hospitals; by Hospital Size Group : 1966 - 1980

Group IV Hospitals

Bed Classification	1966 Beds	1966 % T	1970 Beds	1970 % T	1974 Beds	1974 % T	1978 Beds	1978 % T	1980 Beds	1980 % T	1966-1980 %
Medical	0	0	920	32.8	311	11.1	192	6.1	316	10.0	-
Surgical	0	0	689	24.6	372	13.3	236	7.5	386	12.2	-
Undistributed Med/Surg. (1)	1.927	76.6	468	16.7	1,280	45.8	1,789	57.0	1,479	46.7	-23.2
Sub-Total	1,927	76.6	2,067	73.6	1,963	70.3	2,217	70.6	2,181	68.9	+13.2
Intensive Care	14	0.6	38	1.4	54	1.9	97	3.1	131	4.1	+835.7
Obstetrical	168	6.7	212	7.5	222	7.9	244	7.8	258	8.1	+53.6
Pediatric	192	7.6	241	8.6	311	11.1	281	8.9	269	8.5	+40.1
Psychiatric	106	4.2	211	7.5	199	7.1	205	6.5	235	7.4	+121.7
Other	109	4.3	30	1.1	45	1.6	97	3.1	93	2.9	-14.7
TOTAL	2,516	100	2,809	100	2,794	100	3,141	100	3,167	100	+25.9

APPENDIX 1 (CONT'D)
TABLE 1 - 5
Number and Percentage Distribution of Hospital Beds by Bed Classification for all B.C. Public Hospitals; by Hospital Size Category: 1966 - 1980
Group V Hospitals

Bed Classification	1966 Beds	1966 % T	1970 Beds	1970 % T	1974 Beds	1974 % T	1978 Beds	1978 % T	1980 Beds	1980 % T	1966-1980 %
Medical	0	0	597	27.8	929	35.5	648	28.3	719	29.9	-
Surgical	0	0	550	25.6	1,142	43.7	997	43.5	1,100	45.8	-
Undistributed Med/Surg. (1)	1,596	74.9	506	23.6	34	1.3	109	4.8	76	3.2	-95.2
Sub-Total	1,596	74.9	1,653	77.0	2,105	80.5	1,754	76.5	1,895	78.9	+18.7
Intensive Care	0	0	31	1.4	37	1.4	99	4.3	102	4.2	+229.0*
Obstetrical	164	7.7	160	7.4	137	5.2	125	5.5	100	4.2	-39.0
Pediatric	266	12.5	255	11.9	222	8.5	122	5.3	122	5.1	-54.1
Psychiatric	40	1.9	49	2.3	106	4.1	184	8.0	184	7.7	+360.0
Other	64	3.0	0	0	7	0.3	8	0.3	0	0	-100.0
TOTAL	2,130	100	2,148	100	2,614	100	2,292	100	2,403	100	+12.8

* Percentage change calculated from 1970 to 1980

APPENDIX 1 (CONT'D)
TABLE 1 - 6
Number and Percentage Distribution of Hospital Beds by Bed Classification for all B.C. Public Hospitals; by Hosptial Size Group: 1966 - 1980
All Hospitals

Bed Classification	1966 Beds	1966 % T	1970 Beds	1970 % T	1974 Beds	1974 % T	1978 Beds	1978 % T	1980 Beds	1980 % T	1966-1980 %
Medical	0	0	2,775	24.2	2,166	18.1	2,084	17.9	2,351	19.9	-
Surgical	0	0	2,442	21.3	2,332	19.5	2,303	19.8	2,580	21.8	-
Undistributed Med/Surg. (1)	7,330	69.2	2,915	25.4	3,984	33.4	3,665	31.6	3,314	28.0	-54.8
Sub-Total	7,330	69.2	8,132	71.0	8,482	71.1	8,052	69.3	8,245	69.8	+12.5
Intensive Care	26	0.2	163	1.4	242	2.0	373	3.2	415	3.5	+1496.1
Obstetrical	1,190	11.2	1,140	10.0	1.052	8.8	1,012	8.7	998	8.4	-16.1
Pediatric	1,600	15.1	1,553	13.6	1,582	13.3	1,319	11.4	1,252	10.6	-21.8
Psychiatric	192	1.8	356	3.1	525	4.4	618	5.3	680	5.8	+254.2
Other	257	2.4	110	1.0	52	0.4	237	2.0	230	1.9	-10.5
TOTAL	10,595	100	11,454	100	11,935	100	11,611	100	11,820	100	+11.6

APPENDIX 2

TABLE 2 - 1

Number and Percentage Distribution of Laboratory Personnel in B.C. Public Hospitals Showing Percentage Change from Previous Period and Total Percentage Change; by Type of Personnel and Hospital Size Group Group I Hospitals : 1970-1980

Laboratory Personnel Classification	1970		1974		1978		1980		1970-1980
	FTE	%	FTE	%	FTE	%	FTE	%	%
Laboratory(1) Scientist	2.2	1.1	2.9	1.1	1.6	0.4	7.6	1.8	+245.5
Registered (2) Technologist	140.4	67.7	177.0	65.6	250.5	62.7	299.6	69.7	+66.4
Non-Registered Technologist (3)	11.8	5.7	11.1	4.1	16.6	4.2	8.6	2.0	-27.1
Other Staff Technical (4)	5.4	2.6	2.9	1.1	2.5	0.6	6.8	1.6	+1.5
Other Staff Laboratory (5)	47.6	23.0	75.8	28.1	128.4	32.1	107.3	25.0	+27.0
Group I TOTAL	207.4	100	269.7	100	399.6	100	429.8	100	+107.2

(1) Refers to persons holding a recognized degree in an appropriate laboratory discipline. (eg. B.Sc.,M.Sc.,Ph.D.)

(2) Refers to persons registered as a medical laboratory technologist with the Canadian Society of Laboratory Technologists and those persons who could be registered should application be made.

(3) Refers to persons employed as medical laboratory technologists but who are not eligible for registration with C.S.L.T.

(4) Refers to persons qualified through a formal course to function as a laboratory technician but are not qualified for registration as a technologist with the C.S.L.T.

(5) Includes all other laboratory staff. (Clerical, Administrative, etc.)

APPENDIX 2 (CONT'D)
TABLE 2 - 2
Number and Percentage Distribution of Laboratory Personnel in B.C. Public Hospitals Showing Percentage Change From Previous Period and Total Percentage Change; by type of Personnel and Hospital Size Group
Group II and Group III Hospitals : 1970 - 1980

Laboratory Personnel Classification	1970		1974		1978		1980		1970-1980
	FTE	%	FTE	%	FTE	%	FTE	%	%
GROUP II									
Laboratory Scientists	0	0	0.1	0.0	0.8	0.3	0	0	-
Registered Technologists	124.6	71.3	170.7	74.3	214.7	76.7	237.0	76.2	+74.6
Non-Registered Technologists	14.0	8.0	5.9	2.6	3.5	1.2	2.6	0.8	-81.4
Other Staff, Technical	3.1	1.8	5.1	2.2	3.6	1.3	6.8	2.2	+1.9
Other Staff, Laboratory	33.1	18.9	47.8	20.8	57.5	20.5	64.8	20.8	+20.3
Group II TOTAL	174.7	100	229.6	100	280.1	100	311.2	100	+78.1
GROUP III	FTE	%	FTE	%	FTE	%	FTE	%	%
Laboratory Scientists	0	0	0	0	0	0	0	0	-
Registered Technologists	69.7	65.2	98.2	71.1	103.0	72.0	106.5	74.6	+70.7
Non-Registered Technologists	7.3	6.8	4.6	3.4	2.0	1.4	1.5	1.0	-79.4
Other Staff, Technical	1.8	1.7	3.1	2.2	6.6	4.6	6.1	4.3	+3.2
Other Staff, Laboratory	28.2	26.3	32.3	23.4	31.5	22.0	28.7	20.1	+22.9
Group III TOTAL	107.0	100	138.1	100	143.2	100	142.8	100	+33.4

APPENDIX 2 (CONT'D)
TABLE 2 - 3
Number and Percentage Distribution of Laboratory Personnel in B.C. Public Hospitals Showing Percentage Change From Previous Period and Total Percentage Change; by Type of Personnel and Hospital Size Group
Group IV and Group V Hospitals : 1970 - 1980

Laboratory Personnel Classification	1970		1974		1978		1980		1970-1980
	FTE	%	FTE	%	FTE	%	FTE	%	%
GROUP IV									
Laboratory Scientists	18.9	5.5	9.0	2.4	7.3	1.9	5.5	1.0	-94.7
Registered Technologists	208.8	60.3	247.5	64.8	263.0	68.7	370.9	66.3	+66.0
Non-Registered Technologists	4.9	1.4	3.6	1.0	3.3	0.9	4.7	0.8	-4.0
Other Staff, Technical	32.5	9.4	35.5	9.3	45.5	11.8	50.3	9.0	+9.9
Other Staff, Laboratory	81.4	23.5	86.2	22.6	63.9	16.7	127.7	22.8	+21.4
Group IV TOTAL	346.5	100	381.9	100	383.0	100	559.1	100	+61.3
GROUP V	FTE	%	FTE	%	FTE	%	FTE	%	%
Laboratory Scientists	14.0	3.6	6.9	1.7	4.0	0.8	7.5	1.3	-46.4
Registered Technologists	211.6	54.5	245.3	59.2	313.1	61.6	352.3	60.0	+58.8
Non-Registered Technologists	24.6	6.3	8.0	1.9	11.2	2.2	13.4	2.3	-45.5
Other Staff, Technical	41.1	10.6	59.5	14.4	62.1	12.2	76.7	13.4	+12.6
Other Staff, Laboratory	97.2	25.0	94.6	22.8	117.8	23.2	136.9	23.3	+23.6
Group V TOTAL	388.5	100	414.3	100	508.1	100	586.9	100	+51.0

APPENDIX 3

Comparative Use of Laboratory Assistants in B.C. Public Hospitals by Size of Hospital: 1970 -1980

H	1970			1974			1978			1980		
	Beds	Units	FTE	Beds	Units	FTE	Beds	Units	FTE	Beds	Units	FTE
1	100	708779	1.0	100	844370	1.5	118	1229397	1.0	118	1465796	0.8
2	128	1046253	1.0	128	1341181	1.0	125	1229397	1.0	160	2488612	2.7
3	151	1610852	1.1	141	2182975	1.0	154	2439784	1.6	144	1708065	0.5
4				151	2254681	1.6				170	2540446	2.8
5	225	2864104	1.0	237	3676735	1.4	225	2394321	1.1	226	2297531	1.7
7	261	2099028	0.8	252	1925550	1.0	274	4223911	1.0	288	5865354	4.5
8				274	3712719	0.7	288	5147662	4.5			
9	313	3314174	6.2	418	7076998	8.2	391	5908827	8.9	415	5792513	3.7
10	430	5900682	8.2	766	12799973	27.2	397	4556390	2.7	455	6424631	10.5
11	604	7720264	18.1				413	8501392	10.0	456	5760793	12.0
12							463	10253970	24.0			

H = Hospital sequence number.
Beds = Number of acute care beds.
Units = Number of laboratory workload units.
FTE = Number of staff in laboratories in terms of FTE.

APPENDIX 4

TABLE 4 - 1

Number and Percentage Distribution of Registered Technologists in B.C. Public Hospitals by Qualification and Whether Full-Time of Part-Time and by Hospital Size Group : 1970 - 1980

Qual.	1970				1974				1978				1980			
GROUP I	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%
R.T.	111	90	23	96	150	92	20	95	197	92	41	93	226	89	48	100
A.R.T.	5	4	0	0	8	5	1	5	18	8	2	6	26	11	0	0
Licen.	8	7	1	4	5	3	0	0	0	0	1	2	1	0.4	0	0
TOTAL	124	100	24	100	163	100	21	100	215	100	44	100	253	100	48	100
GROUP II																
R.T.	107	96	13	100	138	95	29	100	153	87	38	95	181	92	42	100
A.R.T	4	4	0	0	8	6	0	0	22	13	2	5	15	8	0	0
Licen.	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	112	100	13	100	146	100	29	100	175	100	40	100	196	100	42	100
GROUP III																
R.T	54	90	6	100	89	95	11	100	77	89	15	100	70	82	18	100
A.R.T.	6	10	0	0	5	5	0	0	10	11	0	0	12	14	0	0
Licen.	0	0	0	0	0	0	0	0	0	0	0	0	3	4	0	0
TOTAL	60	100	6	100	94	100	11	100	87	100	15	100	85	100	18	100

FT = Full Time Technologist
PT = Part Time Technologist
% = Percentage distribution of technologsits by qualification
Qual.= Level of qualification; R.T.= Registered Technologist;
A.R.T.= Advanced Registered Technologist; Licen.= Licentiate

APPENDIX 4 (cont'd)
The number and Percentage Distribution of Registered Technologists in B.C. Public Hospitals by Qualification and Whether Full-Time or Part-Time and by Hospital Size Group: 1970 - 1980

Qual.	1970				1974				1978				1980			
GROUP IV	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%
R.T.	153	79	3	60	190	81	16	100	165	52	17	50	260	83	50	96
A.R.T.	38	20	2	40	45	19	0	0	117	37	14	41	49	16	0	0
Licen.	1	1	0	0	0	0	0	0	37	11	3	9	1	1	2	4
TOTAL	192	100	5	100	235	100	16	100	319	100	28	100	310	100	52	100
GROUP V																
R.T.	176	93	9	90	206	90	19	95	288	98	39	100	330	95	43	98
A.R.T.	12	6	1	10	17	7	1	5	6	2	0	0	16	5	1	2
Licen.	2	1	0	0	7	3	0	0	1	0	0	0	0	0	0	0
TOTAL	190	100	10	100	230	100	20	100	295	100	39	100	346	100	44	100

FT = Full-Time technologists
PT = Part-Time technologists
% = Percentage distribution of technologists by qualification
Qual.= Level of qualification; R.T.= Registered Technologist;
A.R.T.= Advanced Registered Technologist; Licen.= Licentiate

APPENDIX 5

Number and Distribution of Laboratory Medical Manpowerin B.C. Public Hospitals by Position Status and Hospital Size Group : 1970 -1980

Medical Manpower Category	1970				1974				1978				1980			
	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%	FT	%	PT	%
GROUP I																
Pathol.	5	100	20	100	5	100	12	86	5	100	10	63	7	100	10	53
Other	0	0	0	0	0	0	2	14	0	0	6	37	0	0	9	47
TOTAL	5	100	20	100	5	100	14	100	5	100	16	100	7	100	19	100
GROUP II																
Pathol.	2	100	7	100	3	100	11	100	4	100	1	17	2	100	1	33
Other	0	0	0	0	0	0	0	0	0	0	5	83	0	0	2	67
TOTAL	2	100	7	100	3	100	11	100	4	100	6	100	2	100	3	100
GROUP III																
Pathol.	6	100	0	0	7	100	0	0	7	100	0	0	8	100	1	100
Other	0	0	1	100	0	0	1	100	0	0	0	0	0	0	0	0
TOTAL	6	100	1	100	7	100	1	100	7	100	0	0	8	100	1	100
GROUP IV																
Pathol.	25	89	1	50	35	95	3	50	27	90	12	52	28	88	18	82
Other	3	11	1	50	2	5	3	50	3	10	11	48	4	12	4	18
TOTAL	28	100	2	100	37	100	6	100	30	100	23	100	32	100	22	100
GROUP V																
Pathol.	14	64	5	71	13	50	8	80	21	96	28	88	23	85	37	90
Other	8	36	2	29	13	50	2	20	1	4	4	12	4	15	4	10
TOTAL	22	100	7	100	26	100	10	100	22	100	32	100	27	100	41	100

FT = Full-Time positions; PT = Part-Time positions.
% = Percentage distribution of laboratory medical manpower
Pathol.= Pathologists; Other = Other laboratory physicians

APPENDIX 6

TABLE 6 - 1

Distribution of Laboratory Workload for All B.C. Public Hospitals Showing Total Units by Service, Percent of Total Workload, and Percent Change From Previous Period

Group I Hospitals : 1970 - 1980

Category of Service	1970 units x1000	1970 % T	1974 units x1000	1974 % T	1974 % C	1978 units x1000	1978 % T	1978 % C	1980 units x1000	1980 % T	1980 % C
Chem.	3694	20.1	6203	22.7	67.9	10594	24.7	70.8	12323	25.1	16.3
Hematol.	3362	18.3	4627	16.9	37.6	7372	17.2	59.3	8407	17.1	14.0
Blood Bk	556	3.0	1459	5.3	162.0	1634	3.8	12.1	1829	3.7	11.8
Histol.	622	3.4	720	2.6	15.7	1183	2.8	64.4	1638	3.3	38.4
Cytology	4077	22.2	6657	24.4	63.3	8938	20.9	34.3	8620	17.6	-3.6
Microbi.	2567	14.0	2371	8.7	-7.6	4530	10.6	91.0	6226	12.7	37.5
Services	423	2.3	553	2.0	30.7	0	0	-	0	0	-
Procure.	2105	11.4	3506	12.8	66.5	5486	12.8	56.5	6226	12.7	13.5
Other	992	5.4	1227	4.5	23.6	3113	7.3	153.7	3793	7.7	21.9
Distrib. TOTAL(1)	18674	100	27323	100	48.5	42852	100	56.8	49063	100	14.5
Actual TOTAL(2)	19674		29071		47.8	42859		47.4	49063	100	14.5

units=Laboratory workload units.

% T = Percent of total laboratory workload reported in that period.

% C = Percent change from previous period.

(1) = Total of laboratory workload reported in distributed form. This is the total used to calculate % T.

(2) = Total of all laboratory workload reported in that period. This is the total used to calculate overall changes between reporting periods.

This difference in totals only occurred in the smaller hospitals of Group I which likely did not process enough laboratory work to make it worth while reporting in categories.

APPENDIX 6

TABLE 6 - 2

Distribution of Laboratory Workload for all B.C. Public Hospitals Showing Total Units by Service, Percent of Total Workloads, and Percent Change From Previous Period

GROUP II Hospital : 1970 - 1980

Category of Service	1970 units (x1000)	1970 % T	1974 units (x1000)	1974 % T	1974 % C	1978 units (x1000)	1978 % T	1978 % C	1980 units (x1000)	1980 % T	1980 % C
Chem.	5639	30.7	8534	30.5	51.2	10805	31.7	26.8	12771	32.2	18.2
Hematol.	3924	21.4	6051	21.7	54.2	5659	16.6	-6.5	5842	14.7	3.2
Blood Bk	1366	7.4	2284	8.2	67.2	3288	9.7	44.0	3712	9.4	12.9
Histol.	397	2.2	1036	3.7	161.1	1323	3.9	27.7	1644	4.2	24.2
Cytology	10	0.1	4	0.0	-64.2	14	0.0	283.8	23	0.0	61.1
Microbi.	3421	18.6	4403	15.8	28.7	6382	18.8	45.0	8023	20.2	25.7
Services	633	3.4	1012	3.6	60.0	0	0	-	0	0	-
Procure.	2009	10.9	3423	12.3	70.4	4600	13.5	34.4	5452	13.8	18.5
Other	982	5.3	1181	4.2	20.2	1959	5.8	65.9	2183	5.5	11.4
TOTAL	18380	100	27917	100	51.9	34030	100	21.9	39649	100	16.5

units = Laboratory workload units.

% T = Percent of total laboratory workload in that period.

% C = Percent change from previous year.

APPENDIX 6
TABLE 6 - 3
Distribution of Laboratory Workload for all B.C. Public Hospitals
Showing Total Units by Service, Percent of Total Workload, and
Percent Change From Previous Period
GROUP III Hospitals : 1970 - 1980

Category of Service	1970 units (x1000)	% T	1974 units (x1000)	% T	% C	1978 units (x1000)	% T	% C	1980 units (x1000)	% T	% C
Chem.	2854	25.9	5207	27.7	82.4	4491	26.1	-13.8	4372	25.6	-2.6
Hematol.	1794	16.3	3262	17.4	81.8	2450	14.2	-24.9	2389	14.0	-2.5
Blood Bk	1134	10.3	2429	13.5	123.0	2161	12.6	-14.5	2022	11.8	-6.5
Histol.	1268	11.5	1541	8.2	21.5	1918	11.1	24.5	1849	10.8	-3.6
Cytology	4	0.0	13	0.0	209.1	121	0.7	811.5	139	0.8	15.0
Microbi.	2168	19.7	2262	12.1	4.3	2947	17.1	30.3	3177	18.6	7.8
Services	388	3.5	792	4.2	104.2	0	0	-	0	0	-
Procure.	873	7.9	2039	10.9	133.5	2170	12.6	6.4	1855	10.8	-14.5
Other	546	4.9	1133	6.0	107.5	951	5.5	-16.1	1303	7.6	37.0
TOTAL	11031	100	18778	100	70.2	17210	100	-8.4	17106	100	-0.6

units = Laboratory workload units.
% T = Percent of total laboratory workload for that period.
% C = Percent change from previous period.

APPENDIX 6
TABLE 6 - 4
Distribution of Laboratory Workload for all B.C. Hospitals
Showing Total Units by Service, Percent of Total Worload, and
Percent Change From Previous Period
GROUP IV Hospitals : 1970 -1980

Category of Service	1970 units (x1000)	1970 % T	1974 units (x1000)	1974 % T	1974 % C	1978 units (x1000)	1978 % T	1978 % C	1980 units (x1000)	1980 % T	1980 % C
Chem.	8467	25.2	11536	27.8	36.2	14184	25.2	23.0	15372	25.1	8.4
Hematol.	5899	17.6	7115	17.1	20.6	7399	13.1	4.0	8448	13.8	14.2
Blood Bk	2545	7.6	3693	8.9	45.1	7282	12.9	97.2	7460	12.2	2.4
Histol.	3923	11.7	5342	12.9	36.2	7362	13.1	37.8	8243	13.4	12.0
Cytology	174	0.5	227	0.5	30.3	401	0.7	76.7	795	1.3	98.1
Microbi.	8920	26.6	8104	19.5	-9.1	11026	19.6	36.1	12022	19.6	99.0
Services	249	0.7	580	1.4	133.5	0	0	-	0	0	-
Procure.	1922	5.7	3208	7.7	66.9	6577	11.7	105.0	6577	10.7	0.0
Other	1455	4.3	1718	4.1	18.1	2115	3.7	23.1	2376	3.9	12.3
TOTAL	33555	100	41524	100	23.7	56346	100	35.7	61292	100	8.8

units = Laboratory workload units.
% T = Percent of total laboratory workload for that period.
% C = Percent change from previous reporting period.

APPENDIX 6
TABLE 6 - 5
Distribution of Laboratory Workload for all B.C. Public Hospitals Showing Total Units by Service, Percent of Total Workload, and Percent Change From Previous Period
GROUP V Hospitals: 1970 - 1980

Category of Service	1970 units (x1000)	1970 % T	1974 units (x1000)	1974 % T	1974 % C	1978 units (x1000)	1978 % T	1978 % C	1980 units (x1000)	1980 % T	1980 % C
Chem.	13225	32.3	13487	30.1	2.0	16628	27.7	23.3	18062	26.6	8.6
Hematol.	5863	14.3	6380	14.2	8.8	7182	12.0	12.6	8906	13.1	24.0
Blood Bk	4587	11.2	7249	16.2	58.0	10969	18.3	51.3	12023	17.7	9.6
Histol.	4522	11.1	4565	10.2	0.9	6240	10.4	63.3	7012	10.3	12.4
Cytology	410	1.0	393	0.9	-4.2	318	0.5	19.1	1358	2.0	327.3
Microbi.	6719	16.4	4331	9.7	-35.5	7420	12.4	71.3	9209	13.6	24.1
Services	620	1.5	601	1.3	-3.1	0	0	-	0	0	-
Procure.	2586	6.3	3401	7.6	31.5	6612	11.0	94.4	7140	10.5	8.0
Other	2364	5.8	4419	9.9	87.0	4609	7.7	4.3	4073	6.0	11.6
TOTAL	40896	100	44825	100	9.6	59977	100	33.8	67783	100	13.0

units = Laboratory workload units.
% T = Percent of total units for that period.
% C = Percent change from previous period.

APPENDIX 7
TABLE 7 - 1
Summary of Total Laboratory Workload in Workload Units and Percentage Change Between Periods, for all B.C. Public Hospitals by Size Group
1970 - 1980

Hospital Size Group	1970 units (x1000)	1974 units (x1000)	1974 % C	1978 units (x1000)	1978 % C	1980 units (x1000)	1980 % C	1970-1980 % C
Group I	19,674	29,071	47.8	42,859	47.4	49,063	14.5	+149.3
Group II	18,380	27,917	51.9	34,030	21.9	39,649	16.5	+115.7
Group III	11,031	18,778	70.2	17,210	-8.4	17,106	-0.6	+55.0
Group IV	33,555	41,524	23.7	56,346	35.7	61,292	8.8	+82.6
Group V	40,896	44,825	9.6	59,977	33.8	67,783	13.0	+65.7
TOTAL	123,536	162,115	31.2	210,421	29.7	234,894	11.6	+90.1

% C = percent change between periods.
1970-1980 % C = total percent change between 1970 and 1980
All workload expressed in Statistics Canada workload units

APPENDIX 7 (CONT'D)
TABLE 7 - 2
Laboratory Workload Directly Attributable to Inpatient Care in Workload Units for all B.C. Public Hospitals by Size (1)
1970 -1980

Hospital Size Group	1970 units	1974 units	1978 units	1980 units
Group I	9,086,018	10,956,647	12,935,249	14,561,445
Group II	12,619,950	16,220,690	18,042,735	20,188,132
Group III	7,339,230	11,173,058	9,954,982	8,298,975
Group IV	20,511,369	22,846,378	31,619,960	33,406,225
Group V	23,970,952	25,012,111	38,015,746	40,790,400
TOTAL	73,527,519	86,208,884	110,568,672	117,245,177

(1) Does not include quality control or development work related to inpatients.

APPENDIX 7 (CONT'D)
TABLE 7 - 3
Laboratory Workload Directly Attributable to Outpatient Care
in Workload Units for all B.C. Public Hospitals by Size
1970 - 1980

Hospital Size Group	1970 units	1974 units	1978 units	1980 units
Group I	7,824,036	5,924,122	11,270,001	14,012,501
Group II	2,774,994	5,841,092	8,015,622	9,852,563
Group III	1,262,992	2,297,155	2,812,724	3,399,767
Group IV	3,544,951	5,928,922	8,475,087	10,211,542
Group V	2,996,186	3,196,598	4,828,801	6,182,237
TOTAL	18,403,159	23,187,889	35,402,235	43,658,610

(1) Does not include quality control or development work related to outpatients.

APPENDIX 7 (CONT'D)
TABLE 7-4
Distribution of Laboratory Workload by Percent of Total,
in Workload Units for all B.C. Public Hospitals by Size
1970 - 1980

Hospital Size Group	1970				1974				1978				1980			
	% IP	% OP	% RI	% OTH	% IP	% OP	% RI	% OTH	% IP	% OP	% RI	% OTH	% IP	% OP	% RI	% OTH
Group I	46	40	2	12	38	20	26	16	30	26	24	19	30	29	23	19
Group II	69	15	2	14	58	21	5	16	53	24	5	19	51	25	5	20
Group III	67	11	6	16	60	12	6	23	58	16	7	19	49	20	8	24
Group IV	61	11	11	17	55	14	10	21	56	15	10	19	55	16	10	19
Group V	69	7	10	24	56	7	10	28	63	8	8	21	60	9	9	22
TOTAL	60	15	8	18	53	14	11	21	53	17	11	20	50	19	21	21

IP = Inpatient workload
OP = Outpatient workload
RI = Referred-in workload
OTH = Other laboratory workload; includes quality control, standards, Research and Development, and Routine Health Examines.
Percentages have been rounded to the nearest whole number.

APPENDIX 8

TABLE 8 - 1

Laboratory Operating Expenses by Category of Expense Showing Percentage Change Between Periods and Percentage Distribution, for all B.C. Public Hospitals by Hospital Size Groups: 1966 - 1980

(Presented in 1971 Dollars)

Group I and II Hospitals

Expense Category	1966		1970			1974			1978			1980			1966-1980
	$ (x1000)	% T	$ (x1000)	% T	% C	$ (x1000)	% T	% C	$ (x1000)	% T	% C	$ (x1000)	% T	% C	%
GROUP I HOSPITALS															
Med. Sal.	59	5.3	167	7.2	184.3	196	5.7	17.4	353	6.1	79.6	446	6.6	26.5	+658.7
Oth. Sal.	608	55.1	1,387	59.3	228.4	2,308	67.1	66.4	3,810	66.0	65.1	4,269	63.6	12.0	+601.7
Sup.& Exp.	437	39.6	783	33.5	79.0	935	27.2	19.3	1,611	27.9	72.3	1,999	29.8	24.1	+357.1
TOTAL	1,105	100	2,337	100	111.6	3,439	100	47.2	5,773	100	67.9	6,714	100	16.3	+507.9
GROUP II HOSPITALS															
Med. Sal.	116	10.0	138	6.8	19.1	245	7.5	78.1	224	4.9	-8.6	203	4.0	-9.5	+75.5
Oth. Sal.	652	56.5	1,178	58.1	80.8	1,983	60.8	68.3	2,713	59.8	36.8	3,010	58.9	11.0	+361.9
Sup.& Exp.	386	33.5	712	35.1	84.3	1,034	31.7	45.2	1,597	35.2	54.5	1,894	37.1	18.6	+390.3
TOTAL	1,153	100	2,028	100	75.8	3,262	100	60.9	4,534	100	39.0	5,107	100	12.6	+342.7

Med. Sal.= Medical Salaries, Oth. Sal.= Other Salaries, Sup.& Exp.= Supplies and Expenses

$ = Laboratory operating costs in 1971 dollars.

% T = Percent of total expenses for that period.

% C = Percent change between periods.

APPENDIX 8 (CONT'D)
TABLE 8 - 2
Laboratory Operating Expenses by Category of Expense Showing Percentage Change Between Periods and Percentage Distribution for all B.C. Public Hospitals by Hospital Size Group: 1966 - 1980
(Presented in 1971 dollars)
Group III and IV Hospitals

Expense Category	1966		1970			1974			1978			1980			1966-1980
	$ (x1000)	% T	$ (x1000)	% T	% C	$ (x1000)	% T	% C	$ (x1000)	% T	% C	$ (x1000)	% T	% C	%
GROUP III HOSPITALS															
Med. Sal.	74	17.2	285	21.5	284.7	411	18.8	44.0	445	18.2	8.2	454	18.2	2.1	+512.3
Oth. Sal.	241	56.0	748	56.4	210.2	1,215	55.6	62.5	1,390	56.9	14.4	1,426	57.2	2.5	+491.3
Sup.& Exp.	115	26.7	292	22.0	154.4	560	25.6	91.7	607	24.8	8.3	615	24.6	1.3	+435.3
TOTAL	430	100	1,326	100	208.2	2,187	100	64.9	2,442	100	11.7	2,495	100	2.2	+480.0
GROUP IV HOSPITALS															
Med. Sal.	276	16.7	836	24.1	203.0	1,249	23.0	49.4	1,495	18.4	19.7	1,861	20.5	24.5	+574.6
Oth. Sal.	991	59.6	2,059	59.4	107.8	3,300	60.8	60.3	5,063	62.2	53.4	5,514	60.7	8.9	+456.4
Sup.& Exp.	396	23.8	574	16.6	44.9	878	16.2	52.9	1,588	19.5	80.9	1,714	18.9	7.9	+332.7
TOTAL	1,663	100	3,469	100	108.6	5,327	100	56.4	8,146	100	50.1	9,190	100	11.6	+446.6

Med. Sal.= Medical Salaries, Oth. Sal.= Other Salaries, Sup.& Exp.= Supplies and Expenses
$ = Laboratory operating expenses in 1971 dollars.
% T = Percent of total expenses for that period.
% C = Percent change between periods.

APPENDIX 8 (CONT'D)

TABLE 8 - 3

Laboratory Operating Expenses by Category of Expense Showing Percentage Change Between Periods and Percentage Distribution for all B.C. Public Hospitals by Hospital Size Group: 1966 - 1980
(Presented in 1971 dollars)
Group V Hospitals and All Hospitals Combined

Expense Category	1966		1970			1974			1978			1980			1966-1980
GROUP V HOSPITALS	$ (x1000)	% T	$ (x1000)	% T	% C	$ (x1000)	% T	% C	$ (x1000)	% T	% C	$ (x1000)	% T	% C	%
Medical	497	23.0	836	22.2	68.2	1,005	17.8	20.3	1,327	17.1	32.0	1,704	17.7	28.5	+243.0
Oth. Sal.	1,187	54.9	2,673	71.0	125.2	3,558	63.0	33.1	4,656	60.1	30.9	5,540	57.4	19.0	+366.7
Sup.& Exp.	480	22.2	256	6.8	-46.6	1,081	19.2	321.9	1,761	22.7	62.9	2,411	25.0	36.9	+402.0
TOTAL	2,164	100	3,766	100	74.0	5,644	100	49.9	7,744	100	37.2	9,655	100	24.7	+346.1
ALL B.C. HOSPITALS															
Med. Sal.	1,021	15.7	2,262	17.5	121.5	3,107	15.6	37.3	3,843	13.4	23.7	4,669	14.1	21.5	+357.1
Oth. Sal.	3,679	56.5	8,045	62.2	118.7	12,364	61.9	53.7	17,732	61.6	42.6	19,759	59.8	12.1	+437.0
Sup.& Exp.	1,815	27.9	2,618	20.3	41.9	4,488	22.5	71.4	7,164	25.0	59.6	8,633	26.1	20.5	+375.7
TOTAL	6,515	100	12,925	100	98.4	19,959	100	54.4	28,640	100	43.5	33,061	100	15.4	+407.4

Med. Sal.= Medical Salaries, Oth. Sal.= Other Salaries, Sup.& Exp.= Supplies and Expenses
$ = Laboratory operating expenses in 1971 dollars.
% T = Percent of total expenses for that period.
% C = Percent change between periods.

APPENDIX 9

The Number of Hospitals in Each Size Group for Each Period.
1966 -1980

Hospital Size Group	1966	1970	1974	1978	1980
GROUP I	87	82	85	80	80
GROUP II	18	19	19	19	19
GROUP III	3	5	6	5	4
GROUP IV	6	6	6	7	7
GROUP V	2	2	3	4	4
TOTAL	116	114	119	115	114

GROUP I = Hospitals with less than 100 beds.
GROUP II = Hospitals with between 100 and 199 beds.
GROUP III = Hospitals with between 200 and 299 beds.
GROUP IV = Hospitals with over 300 beds excluding teaching hospitals.
GROUP V = Teaching Hospitals.