Identifying determinants for hospitalization based on healthcare utilization records

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Foreword

This report has its origin in the need for better information to guide primary health care reform at the community level. Although its role is relatively small in terms of population level health impact, medical care, as a determinant of health, is very expensive. Several analyses are available describing the patterns of medical care use by populations - both at the primary care level and at the acute hospital level, but seldom both together in a linked manner. Furthermore, few studies have looked at data at the local community and neighborhood levels.

Primary health care is "the first level of contact of individuals, the family and community with the ... health system, bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process" (World Health Organization [WHO], 1978). To do primary health care well, we need the right information at the level of "where people live and work" that can inform local service planning decisions. Nothing speaks more eloquently, on the urgency of this need for local information, than the challenges we face in addressing the ever expanding societal burden from chronic health conditions.

With the support of the Ministry of Health, we looked at the patterns of health care use by Richmond residents as recorded in the Medical Services Plan (MSP) and Hospital Discharge Abstract Databases (DAD). The BC Ministry Health uses the Johns Hopkins University's ACG grouper system to code MSP clients. In an earlier study, using the MSP data alone, we described the use of medical care by Richmond residents for the years 2001-02, 2002-03, 2003-04. We found the main drivers of physician care use to be age, level of complexity and number of chronic conditions, and to a lesser extent, the neighborhood where the residents live. We also found some suggestions that continuity of care, as measured by the presence or absence of a family physician as the majority care provider, influenced overall medical care utilization. For this present study, we linked information from the two databases (MSP and DAD) for the fiscal year of 2003-04. We followed the health care use of Richmond residents from the community setting into the hospital. We modeled the predictors of hospital use.

The results of our analysis both confirmed the findings of other similar studies, and also demonstrated predictors of hospital use not well identified previously, such as the absence of a majority source of care provider being a predictor of high hospital use. Again we also found differences between neighborhoods, a proxy measure for socio-economic status. Richmond Health Services will be using the information to inform ongoing efforts to improve care for chronic conditions. The results point logically to next steps such as chart reviews of high users of hospital care, and the creation of integrated case management across the care continuum. Indeed a number of CDM initiatives are already underway. Our findings clearly support the aims of the BC Primary Health Care Charter to create community based Integrated Health Networks. We trust the report will be of value to our colleagues in the Health Authorities and the Ministry.

This is a collaborative project between the Provincial Health Services Authority (PHSA) and Richmond Health Services of Vancouver Coastal Health. We are indebted to the Ministry of Health for releasing the MSP and DAD data used in this study, and to Ministry staff for assistance in formulating the questions and overcoming data challenges. Special thank you to key individuals are found in the Acknowledgement.

James Lu
Medical Health Officer, Richmond
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Preface

Over the past century, significant improvements in public health, medicine, living and working conditions and nutrition have led to a dramatic increase in life expectancy. The aging population is vulnerable to various chronic health conditions and these conditions in turn place severe demands on our health care resources and system. In order to assure the sustainability of medical services and hospital care, we need to identify the risk factors for healthcare utilization and reduce the corresponding risks through early policy intervention.

As a joint project between Vancouver Coastal Health (VCH) and the Provincial Health Services Authority (PHSA), we looked into utilization patterns of the health care records from the residents in the City of Richmond. Taking hospital care (which accounts for about 40% of the total healthcare costs in British Columbia) as a point of focus, we make evident that chronic diseases (especially multiple co-morbidities) have emerged as one of most costly factors for frequent and lengthy hospital stays.

This report further indicates the benefit of engagement of patients with single identifiable family physicians who acts as the majority source of primary care to lower the chance of becoming hospital users. It is hoped that this report will assist in planning more effective policies and programs for both the primary prevention of chronic disease and the more efficient care of those with chronic conditions.

John Millar
PHSA Executive Director
Population Health Surveillance & Disease Control Planning

Executive Summary

Background: People are living longer than ever before in Canada. Therefore, the proportion of the Canadian population middle aged and older is rapidly increasing. Since chronic diseases are positively associated with age, the population living with chronic diseases is also growing. Indeed, people with chronic diseases are increasingly a burden to the health care system. Among all government health expenditures in British Columbia (BC), 40 percent go toward hospital care. Much of these hospital expenses, in turn, are consumed by patients with chronic diseases. Thus, an important focus of public health policy research and development for BC health authorities is in revealing risk factors and reducing risks for hospitalization from chronic diseases through population and system based interventions. The objective of this population-based study, using individual level medical utilization records, is to identify the manageable medical, demographic and geographic contributors to hospital utilization.

Although our analysis was based on the population of Richmond, a single health services delivery area (HSDA) in BC, the diverse nature of its population made Richmond a good representation of the changing BC population structure.

Methods: The study subjects included the entire population of Richmond for the 2003/04 fiscal year (April 1, 2003 to March 31, 2004). The residents' demographic and geographic information drawn from the registration data contained in the BC Client Registry, the medical services records kept in the provincial medical service insurance plan (MSP), and the hospital discharge abstract database (DAD) were linked by the BC Ministry of Health through encrypted identifiers. Multivariate logistic regression was used to model individual level hospital utilization experience against various potential determinant factors. The two modeled outcome variables in this study were: *hospitalization* - whether the person was ever hospitalized in the year, and *extreme hospitalization* - whether the person was among the top 5 percent of hospital patients in terms of annual days spent in hospital. Multivariate statistical modeling enabled us to estimate the separate contributions of demographic, geographic and medical variables to hospital utilization. Also adjusted hospital utilization rates were used to estimate the excess hospital bed days that could be avoided if the between-group differences such as diabetes/non-diabetes, or presence/absence of an identifiable family doctor were eliminated.

Results: We found that some chronic diseases, in particular, cancer, cardiovascular disease, arthritis, chronic renal failure, chronic obstructive pulmonary disease (COPD), mental disorder and diabetes, and high levels of co-morbidity were predictors for both *hospitalization* and *extreme hospitalization*. Moreover, the presence of a single family physician being the majority source of care (in short, a "MSOC" physician) is significantly associated with both reduced risks of *hospitalization* and *extreme hospitalization*. We also observed significant neighbourhood differences in the risk of hospitalization - higher in the economically better-off areas and lower in the ethno-cultural neighbourhoods, indicating an unbalanced use of hospitals and the needs for appropriate community-level health care planning and management. In addition, about 21% excess hospital bed days were used by people without MSOC physicians. Excess hospital bed days used by patients with diabetes, or diabetes along with co-morbidity were also calculated. We further found that among hospital patients, those who ranked within the top 5% in terms of hospital bed days, collectively contributed to 51.5 percent of the total hospital bed days for the entire population in the year.

Discussion: We investigated the strong impact of chronic diseases and co-morbidity on *hospitalization* and *extreme hospitalization*. We found an extraordinarily heavy hospital use among just a small portion of high users. The study result underscored the need to prevent and manage chronic diseases in the community. Hospital utilization can be significantly decreased through efforts to reduce the prevalence of chronic diseases and to improve coordination of their management across the health care system. The finding from this study showing the benefit of having a MSOC physician is encouraging. The presence of MSOC physicians is likely a proxy indicator of better continuity of care. The finding also indicates the necessity of redesigning the health care delivery system at the neighbourhood level in order to respond to the different needs amongst neighbourhoods for hospital care. Our results support better strategies for integrating systematic care of people with diabetes and especially those high levels of co-morbidity in order to lower their dependency on acute hospital care.

Introduction

1.1 Increased Senior Population

As the baby boomers grow older, the number of British Columbians aged 65 and older will double to 1.24 million over the next 20 years while the overall population growth is only expected to be 25%[1]. This projected surge in the number of seniors, and the chronic health conditions often associated with age, will dramatically increase the demand for health and social services[2].

1.2 Improved Survival from Acute Threats and Longer Life Expectancy

Improvements in medicine, nutrition, living and working conditions, and public health have contributed to longer life expectancy and significantly altered the causes of mortality over the past 100 years worldwide[3] and in Canada[4]. People now live longer, but often with chronic health conditions and associated medical complications in the later years of life[5].

Chronic diseases, taken together, place increasingly severe demands on our current health care system[6 7]. Based on statistics from the BC Ministry of Health[8] for the 2005/06 fiscal year, the population with confirmed chronic health conditions, which account for 34% of the total BC population, consumed 80% of health care resources. Furthermore, 86% of hospital costs were expended on patients with confirmed chronic health conditions.

1.3 Chronic Diseases: Preventable and Manageable

Chronic diseases are preventable and when they occur, can be managed to minimize complications[9]. In fact, much evidence is known with respect to effective strategies to combat chronic diseases, ranging from primary to tertiary prevention. The challenge has been and continues to be applying what we already know.

1.4 Examining Geographic Inequalities in Hospital Utilization and the Redesigning Health Care Delivery System at the Neighbourhood Level

Richmond is one of the three health service delivery areas (HSDA) within the Vancouver Coastal Health region in BC. Planning is under way in Richmond to develop primary health care services based on neighborhood-level needs. The planning framework used is given the name *Neighborhood Level Primary Healthcare Organizations (NLPHO)* for Richmond (VCH, 2005)[10]. The first step has been dividing Richmond into five “neighborhoods”, with the goal of creating a coherent network of virtual and co-located inter-disciplinary health care teams and partnerships, functioning at each neighborhood and connected between neighborhoods. It is hoped that the NLPHO framework will ultimately help the Richmond HSDA achieve the vision for primary health care articulated by the Romanow Commission: providing 90% of the health care

needs of the population in a defined neighborhood, minimizing dependence on acute care, accessible 24/7, emphasis on health promotion, prevention, and capable of managing a high degree of complexity and acuity (Romanow, 2002)[11].

1.5 Identifying Determinant Factors for Hospital Utilization

As mentioned above, one third of British Columbians have chronic health conditions, and they in turn use four-fifths of the health care resources, in particular, hospital based care. Who are those people? What are their characteristics? Are there things we can do to help them manage their conditions besides admitting them to hospitals? These are questions that health system planners and policy makers keenly wish for answers. By modeling hospital utilization we recognize patterns of hospitalization and determinant factors for hospitalization. This information can then help us devise approaches to minimize dependence on acute care for managing chronic conditions, and at the same time improve the quality of life of people living with chronic disease.

In terms of analyzing hospital utilization, most studies[12 13 14 15 16] so far are limited to descriptive counts and rates of hospital use, or the statistical modeling on hospitalization risk for one or a few specific patient groups[17 18 19], or general studies based on self-reported survey data[20 21 22] that is subject to sampling and non-sampling errors. As well, stratified multivariate cross tabulations are difficult to implement on survey data due to excessive coefficients of variation. No multivariate statistical modeling at the individual patient level has ever been applied to linked primary care and hospital utilization data for the general Canadian populations. Besides identifying determinant factors for hospital utilization, we further showed excess hospital bed days that could be avoided if the determinant factor such as diabetes, or absence of an identifiable family doctor was eliminated.

We describe in this report the entire analyses of the hospital utilization experiences of Richmond residents, an ethno-culturally diverse urban population in BC.

Methods

2.1 Sources of Data

The BC Ministry of Health maintains a number of administrative databases for health services. Examples of these include databases for MSP, DAD, Pharmanet, and Pharmacare. Each of these databases is person-based, with individual records geographically indexed through postal code for the place of residence and linkable by the Personal Health Number (PHN).

MSP, the Medical Services Plan, is the public funded health insurance that pays for medical services provided to British Columbians. Two data sets from MSP are used in this project: the Client Registry and the Claims Database. The Client Registry contains demographic information for the population served by MSP. Since by law, BC residents are required to be registered with MSP, the MSP Client Registry functions very well as a reasonable and stable source of population denominators. The Claims Database, on the other hand, captures each and every episode of service encounter for which a claim is made to MSP for payment. For each service encounter, the Claims Database records the identity of the person served, the service provider, the nature of the service, and the medical diagnosis necessitating the service.

As well, the Ministry of Health has recently begun using the Johns Hopkins' Case-Mix System[23 24] to aggregate claims by similar diagnoses or morbidity into Aggregated Diagnostic Groups (ADG). A person can be assigned as few as none and as many as thirty-two ADGs representing the level of co-morbidity based on different medical diagnoses in the previous year. Based on a combination of ADGs, age and sex, the Case-Mix System further assigns individuals in the client registry into mutually exclusive Adjusted Clinical Groups (ACG) reflecting their health care resource dependency.

DAD, the hospital Discharge Abstract Database (DAD) maintained by the BC Ministry of Health is also used in this project. Each record in the DAD contains information on an episode of hospital utilization: patient identifier (PHN), hospital identifier, dates of admission and discharge, primary and contributory diagnoses, and procedures performed.

Using the unique PHN, it is possible to link the MSP Clients Registry, Claims Database and the DAD to capture a composite view of health care utilization by a defined population.

As mentioned earlier in the report, this study is part of a larger project on population level primary health care needs in Richmond. For the purpose of the overall project, the BC Ministry of Health granted limited release, to the Medical Health Officer for Richmond, of MSP and DAD data pertaining to Richmond residents for the fiscal years 2001-02, 2002-03, and 2003-04. The data release limitations were designed to ensure compliance with provincial government's confidentiality and privacy protection requirements. Briefly, MSP client registry data, claims data, and DAD, for Richmond residents, were obtained from the Ministry, without personal names, with PHN numbers encrypted, and with individual data aggregated spatially by postal code into the five previously mentioned Richmond primary health care neighbourhoods (see Appendix I). With no personal names, having the PHN encrypted, and no individual postal code, it is not possible to trace back the identity of the individual level data. For the study in this report, only data for the 2003-04 fiscal years were used.

Since our interest is in chronic disease and its hospital care burden, services and hospitalizations due to pregnancy, obstetrics and the associated complications were excluded from the analyses.

The primary health care neighbourhoods in Richmond are described in more detail in the Appendix I. The socio-economic information for the neighbourhoods was supplied by the City of Richmond.

2.2 Definitions

Hospital bed days were calculated as the number of overnights in hospital or a half day for day patients.

Factors under analysis included:

- Demographic and geographic variables: age, sex, and residing neighbourhood;
- Patient type: every resident is assigned into one of the three groups based on the amount and the relationship with general practitioners (GP): A person is considered as a *low GP use patient* if he/she visited any GP less than three times in the fiscal year; or as a *MSOC patient* if he/she had three or more GP visits in the fiscal year and more than 50% (majority source of care - MSOC) of the visits were to a single identifiable GP when receiving core primary care services; or otherwise as a *non-MSOC patient*.

Additionally, medical care related variables included:

- Presence of chronic disease(s): hypertension, diabetes, ischemic heart disease (IHD), congestive heart failure (CHF), chronic renal failure (CRF), cancer, chronic obstructive pulmonary disease (COPD) and allied conditions, mental disorder, and arthritis.
- A person was considered to have a chronic disease if the patient was at least either diagnosed twice of the same disease by any physician as recorded in MSP claims data or hospitalized once with the diagnosis in DAD data within the 12 month period.
- ADG score (the number of ADGs representing the level of co-morbidity and expected resource consumption).
- ACG score reflects both level of healthcare resource use and epidemiological patterns of morbidity. Though the ACG score is an effective hospital utilization predictor[25], it was not used in modeling hospital utilization because it is an aggregated score derived from patients' morbidity and thus the true effect from individual disease can not be separated from it. However, we used ACG as a means of adjustment for hospitalization risk when we estimated savings in hospital utilization between populations with different geographic or other non-medical characters.

Two outcome variables statistically modeled in this study included: *hospitalization,* whether the person was ever hospitalized in the year and *extreme hospitalization*, whether the patient was among the top 5 percent heavy hospital use patients in terms of total number of days spent in hospital in the year. The former represents the risk of using acute care and the latter indicates the risk of becoming heavy hospital users.

2.3 Statistical Analysis

Separate multivariate logistic regression analyses[26 27] were conducted to model the probabilities of becoming hospital users and extreme hospital users against various potential determinant factors. Statistical analysis was conducted with SPSS (Statistical Package for the Social Sciences) software version 14.0 (SPSS, Inc, Chicago, IL).

Logistic regression is used to predict a dependent variable from a single or multiple independents and to determine the percent of variance in the dependent variable explained by the independents. Logistic regression is used when the dependent variable is a dichotomy and the independent variables are of any data type. Technically, logistic regression applies maximum likelihood estimation after transforming the dependent variable by a LOGIT function (the natural log of the odds of the dependent occurring or not). In this way, logistic regression estimates the probability of an event occurring.

It is of great importance to perform multivariate analysis so that the true contributions from each risk factor for hospitalization can be evaluated when the other determining and confounding factors are adjusted. For example, the observed correlation between hypertension and its risk for hospitalization derived from a univariate analysis vanishes in the multivariate analysis when the diabetes factor is added.

Hospitals were not used uniformly between population groups with or without a characteristic of interest, such as MSOC patients versus non-MSOC patients or people with diabetes versus people without the disease. The excess hospital bed days consumed by people with a characteristic of interest is the difference between the observed hospital bed days that they actually used and the expected hospital bed days when the corresponding hospital utilization rates for people without the characteristic are applied. The methodology to calculate excess or "shortfalls" in hospital bed days for a specific population as compared to a baseline population is available from literature[28 29 30] and is described in further detail in Appendix II.

Results

3.1 Reasons for Hospital Admission

For the population under study, 10,487 patients were admitted into hospital care with 14,567 admissions, and a total of 47,466 hospital bed days in the year. As shown in Table 1, the number one reason of using hospitals was circulatory system diseases - 18.1% of total hospital bed days.

From second largest reason to the sixth in descending order were mental disorders (14.0%), injuries (11.1%), digestive system diseases (9.3%), respiratory system diseases (6.1%) and cancer (6.0%).

Table 1 Distribution of hospital bed-days by causes for admission

Causes for Hospitalization	Days	Shares (%)
Total	**47,466**	**100.0**
Infectious & Parasitic Diseases	177	0.4
Cancer	2,847	6.0
Digestive organs and peritoneum	1,107	2.3
Respiratory and intrathoracic organs	232	0.5
Bone, connective tissue, skin and breast	210	0.4
Genitourinary organs	536	1.1
Other solid tumour sites	387	0.8
Lymphatic and haematopoietic tissue	363	0.8
Endocrine, Nutritional and metabolic diseases and immunity disorders	1,050	2.2
Diabetes mellitus	663	1.4
Diseases of Blood and Blood-forming Organs	312	0.7
Mental disorders	6,636	14.0
Organic psychotic conditions	638	1.3
Other psychoses	4,808	10.1
Neurotic, personality and other non-psychotic mental disorders	1,190	2.5
Diseases of the Nervous System and Sense Organs	2,288	4.8
Inflammatory diseases of the central nervous system	73	0.2
Hereditary and degenerative diseases of central nervous system	524	1.1
Other disorders of CNS	297	0.6
Disorders of the peripheral nervous system	103	0.2
Disorder of the eye and adnexa	919	1.9
Diseases of the ear and mastoid process	373	0.8
Diseases of Circulatory System	8,569	18.1
Ischemic heart disease	2,394	5.0
Disease of pulmonary circulation	243	0.5
Other forms of heart disease	2,380	5.0

Causes for Hospitalization	Days	Shares (%)
Cerebrovascular disease	2,574	5.4
Diseases of arteries, arterioles and capillaries	568	1.2
Diseases of Veins and lymphatics and other diseases of circulatory system	234	0.5
Diseases of Respiratory System	2,883	6.1
Acute respiratory infections	130	0.3
Other diseases of the upper respiratory tract	151	0.3
Pneumonia and influenza	767	1.6
COPD and allied conditions	1,318	2.8
Other respiratory system diseases	474	1.0
Diseases of Digestive System	4,435	9.3
Diseases of esophagus, stomach and duodenum	657	1.4
Hernia of abdominal cavity	413	0.9
Non-infectious enteritis and colitis	501	1.1
Other diseases of intestines and peritoneum	1,165	2.5
Other digestive system diseases	1,697	3.6
Diseases of Genitourinary System	2,155	4.5
Nephritis, nephritic syndrome and nephritis	211	0.4
Other diseases of urinary system	903	1.9
Diseases of male genital organs	312	0.7
Disorders of breast	94	0.2
Inflammatory disease of female pelvic organs	90	0.2
Other disorders of female genital tract	546	1.2
Injury and Poisoning	5,249	11.1
Diseases of the Skin and Subcutaneous Tissue	545	1.1
Diseases of the Musculoskeletal System and Connection Tissue	1,869	3.9
Symptoms, Signs and Ill-defined Conditions	2,342	4.9
Other Causes	6,113	12.9

3.2 Age and Sex Effects

Disease rates and health resource dependency are strongly associated with age. We, thus, adjusted for age when other risk factors are modeled in assessing their contributions to hospital utilization.

As shown in Table 2, women had a crude hospital utilization rate of 6.4% [95% confidence interval (CI) 6.3%-6.6%], which was significantly higher than the rate for men of 5.8% [95% CI: 5.6%-6.0%]. Most of the sex gap in hospital use rates was due to differences in age structure. Using a multivariate logistic regression model as shown in Table 3, adjusting for age and disease status, women were actually 21% less likely to use hospital care (odds ratio [OR] 0.79 [95% CI: 0.75–0.82]) than men.

Table 2 Hospital utilization rates by patient groups

Population Group		Population	Total patients	Patient rate (%)	Days in hospital	Days per patient
Total		**171,145**	**10,487**	**6.1 (6.0-6.2)**	**47,466**	**4.5**
Sex	Men	82,954	4,803	5.8 (5.6-6.0)	21,555	4.5
	Women	88,191	5,684	6.4 (6.3-6.6)	25,911	4.6
Age	0-14	27,319	562	2.1 (1.9-2.2)	1,173	2.1
	15-24	24,527	494	2.0 (1.8-2.2)	1,646	3.3
	25-44	49,306	1,692	3.4 (3.3-3.6)	6,065	3.6
	45-64	48,838	3,746	7.7 (7.4-7.9)	12,357	3.3
	65+	21,155	3,993	18.9 (18.3-19.5)	26,226	6.6
Neighbourhood Area	South Arm	34,819	2,173	6.2 (6.0-6.5)	9,886	4.5
	Richmond Centre	33,126	1,842	5.6 (5.3-5.8)	8,590	4.7
	Blundell	33,319	2,300	6.9 (6.6-7.2)	12,266	5.3
	Steveston	34,544	2,289	6.6 (6.4-6.9)	9,207	4.0
	East Richmond	35,337	1,883	5.3 (5.1-5.6)	7,519	4.0
Patient Type	Low GP patients	40,675	356	0.9(0.8-1.0)	1,139	3.2
	MSOC patients	94,500	7,875	8.3(8.1-8.5)	35,562	4.5
	Non-MSOC patients	35,970	2,256	6.3(6.0-6.5)	10,766	4.8
ADG score	None	36,376	138	0.4 (0.3-0.4)	847	6.1
	1-3 conditions	74,441	1,717	2.3 (2.2-2.4)	3,446	2.0
	4-6 conditions	44,343	4,396	9.9 (9.6-10.2)	13,664	3.1
	≥ 7 Conditions	15,985	4,236	26.5 (25.7-27.3)	29,509	7.0
Hypertension patients		11,902	2,025	17.0 (16.3-17.8)	12,576	6.2
Diabetes mellitus patients		5,741	1,161	20.2 (19.1-21.4)	8,818	7.6
COPD and allied conditions		3,296	630	19.1(17.6-20.6)	5,671	9.0
Ischemic heart disease patients		2,518	1,030	40.9 (38.4-43.4)	9,497	9.2
Congestive heart failure patients		403	294	73.0 (64.6-81.3)	5,280	18.0
Chronic renal failure patients		261	167	64.0 (54.3-73.7)	2,710	16.2
Cancer patients		2,503	1,203	48.1 (45.4-50.8)	8,845	7.4
Mental disorder patients		7,645	1,259	16.5 (15.6-17.4)	16,880	13.4
Arthritis patients		4,340	1,127	26.0 (24.5-27.5)	6,827	6.1
Top 5% extreme hospital users		528	528	100.0	24,554	46.5

Also from Table 3, compared with children (aged 0 to 14), risk of hospitalization increased as the population aged: OR 1.39 [95% CI: 1.25-1.54] for people aged between 25 and 44, and up to OR 4.59 [95% CI: 4.07-5.17] for people of 80 and over.

Table 3 Odds ratios of factors[1] contributing to hospitalization

Population Group	Population	Patients	Significance[2]	Odds Ratios (95% CI)
Sex				
Male	82,954	4,803	–	Baseline
Female	88,191	5,684	**	0.79 (0.75 – 0.83)
Age				
≤ 14	27,319	562	–	Baseline
15 – 24	24,527	494		0.88 (0.78 – 1.00)
25 – 44	49,306	1,692	**	1.39 (1.25 – 1.54)
45 – 64	48,838	3,746	**	2.42 (2.19 – 2.67)
65 – 79	15,462	2,642	**	3.64 (3.27 – 4.05)
≥ 80	5,693	1,351	**	4.59 (4.07 – 5.17)
Neighbourhood Areas				
South Arm	34,819	2,173		1.04 (0.97 – 1.12)
Richmond Centre	33,126	1,842		1.00 (0.93 – 1.07)
Blundell	33,319	2,300	**	1.12 (1.05 – 1.20)
Steveston	34,544	2,289	**	1.17 (1.09 – 1.25)
East Richmond	35,337	1,883	–	Baseline
Patient Type				
MSOC patients	94,500	7,875	–	Baseline
Non-MSOC patients	35,970	2,256	**	1.07 (1.02 – 1.14)
Low GP patients	40,675	355	**	0.79 (0.70 – 0.90)
Morbidity and co-morbidities				
ADG I (none)	36,376	138	–	Baseline
ADG II (1-3 conditions)	74,441	1,717	**	4.98 (4.12 – 6.02)
ADG III (4-6 conditions)	44,343	4,396	**	17.20 (14.19 – 20.84)
ADG IV (≥ 7 conditions)	15,985	4,236	**	37.74 (31.07 – 45.86)
Diabetes mellitus	5,741	1,161	**	1.38 (1.27 – 1.49)
COPD and allied conditions	3,296	630	**	1.44 (1.30 – 1.60)
Ischemic heart disease(IHD)	2,518	1,030	**	2.51 (2.28 – 2.77)
Congestive heart failure(CHF)	403	294	**	5.21 (4.05 – 6.71)
Cancer	2,503	1,203	**	4.86 (4.43 – 5.33)
Chronic renal failure(CRF)	261	167	**	6.04 (4.47 – 8.15)
Mental disorder	7,645	1,259	**	1.52 (1.41 – 1.64)
Arthritis	4,340	1,127	**	1.91 (1.76 – 2.07)

1 Influential factors by importance are number of ADGs, age group, cancer, IHD, arthritis, CHF, CRF, metal disorder and sex, diabetes, neighbourhood, and patient type.

2 Significance – * statistical significant at 0.05 level and ** statistical significant at 0.01 level as compared to baseline

3.3 Determinant Factors for Hospitalization

Adjusting for age in the multivariate logistic models, all other potential determinants of hospitalization were examined with the resulting significant contributing factors presented in Table 3.

One of the important findings of this study is the recognition of the benefit to the MSOC patients who receive the majority of primary care services from the same general practitioners. Statistically, the non-MSOC patients were 7% more likely to become hospital users (OR 1.07 [95% CI: 1.02-1.14]).

If all non-MSOC patients had had MSOC physicians, there would have been a reduction of 2,215 hospital bed days or 20.6% among the current non-MSOC patients, after adjusting for the age and ACG structures. We also found some of the low GP use patients actually being relatively high users of other medical services overall. If these *low GP use* patients had had MSOC physicians, there could have been a reduction of 409 hospital bed days or 35.9% for this group of patients, even though the group did not contribute much to the overall hospital use.

As expected, people with chronic health conditions are more likely to be hospitalized. Cancer, ischemic heart disease, arthritis, congestive heart failure, chronic renal failure, mental disorder and diabetes are significant determinant factors for *hospitalization*. Furthermore, level of co-morbidity was a strong determinant factor for *hospitalization*. Compared with people with the lowest ADG score (ADG=0), patients with higher ADG scores had higher chances of becoming hospital patients (OR 4.98 [95% CI: 4.12-6.02] for patients with ADG scores between 1 and 3; OR 17.20 [95% CI: 14.19-20.84] for patients with ADG scores between 4 and 6 and OR 37.74 [95% CI: 31.07-45.86] for patients with ADG scores of 7 or higher).

3.4 Differences in Hospitalization by Neighbourhoods

One of the primary goals of this project was to understand the health services needs and capacity demands at the neighbourhood level. Compared to East Richmond and adjusted for age, sex, chronic disease status and patient type from the multivariate logistic regression analysis, residents from Blundell and Steveston had significantly higher chance of *hospitalization* (OR 1.12 [95% CI: 1.05-1.20] for Blundell area and OR 1.17 [95% CI: 1.09-1.25] for Steveston area, respectively). There was no significant difference in hospitalization among South Arm, Richmond Centre and East Richmond neighbourhoods. The observed significant neighbourhood differences in the risk of *hospitalization* - higher in the economically better-off areas (Steveston and Blundell) and lower in the ethno-cultural neighbourhoods (East Richmond and Richmond Centre) indicate unbalanced uses of hospital acute care and the needs for further investigation on utilization patterns against socioeconomic gradient.

If we had eliminated neighbourhood differences by assuming the same degree of health resource dependency through applying the same age- and ACG-specific hospital rates for East Richmond to the rest of Richmond, there would have been a reduction of 6,057 hospital bed days, or 12.8% for Richmond.

Geographic differences in hospital utilization revealed in this study can help to optimally plan and allocate health services resources across neighbourhoods in Richmond.

3.5 Extreme Hospital Use

Another significant finding of this study is the determination that the top 5 percent of hospital users accounted for 51.5% of the total hospital bed days spent by Richmond residents, whereas the other 95% hospital users only consumed the remaining 48.5% of hospital resources. As shown in Table 4, the most common causes for hospital admission for these patients at the 95th percentile of hospital use were mental health disorders (21.9%), circulatory system diseases (17.5%), injuries and poisoning (11.6%), and respiratory system diseases (5.2%).

Table 4 How hospital bed days were used by the extreme hospital users

Population Group	Patients	Days in hospital	Share (%)	Days per patient
Extreme hospital users	**528**	**24,554**	**100.0**	**46.5**
Infectious and parasitic diseases	6	144	0.6	24.0
Cancer	90	1,101	4.5	12.2
Endocrine, nutritional and metabolic diseases and immunity disorders	74	575	2.3	7.8
Diseases of blood and blood-forming Organs	14	104	0.4	7.4
Mental disorders	190	5,384	21.9	28.3
Nervous system & sense organs	68	1,016	4.1	14.9
Diseases of circulatory system	285	4,295	17.5	15.1
Diseases of respiratory system	90	1,284	5.2	14.3
Diseases of digestive system	84	992	4.0	11.8
Diseases of genitourinary system	46	385	1.6	8.4
Injury and poisoning	134	2,843	11.6	21.2
Diseases of the skin and subcutaneous tissue	37	339	1.4	9.2
Musculoskeletal system and connection tissue	52	633	2.6	12.2
Arthritis	26	319	1.3	12.3
Symptoms, signs and ill-defined conditions	75	1,119	4.6	14.9
Other causes	156	4,342	17.7	27.8
Neighbourhood areas				
South Arm	107	4,981	20.3	46.6
Richmond Centre	98	4,549	18.5	46.4
Blundell	146	6,991	28.5	47.9
Steveston	96	4,449	18.1	46.3
East Richmond	81	3,584	14.6	44.2
Patient Type				
Low GP patients	13	571	2.3	43.9
MSOC patients	399	18,302	74.5	45.9
Non-MSOC patients	116	5,681	23.1	49.0
Sex				
Males	233	10,889	44.3	46.7

Population Group	Patients	Days in hospital	Share (%)	Days per patient
Females	295	13,665	55.7	46.3
Age Group				
0 – 44	87	4,144	16.9	47.6
45 – 64	100	5,026	20.5	50.3
65 – 79	156	7,189	29.3	46.1
≥ 80	185	8,195	33.4	44.3

Percentages are subject to rounding errors and may not add up to the total.

3.6 Determinant Factors for Extreme Hospital Use

The determinants of *hospitalization*: sex and neighbourhood area were not associated with *extreme hospitalization*. Adjusted for age in the multivariate logistic model, all the potential risk factors were examined and the contributing risk factors for heavy hospital use are presented in Table 5.

This study of *extreme* users further recognized the important role that MSOC physicians have in influencing hospital use. Patients without MSOC physicians were 39% more likely (OR 1.39 [95% CI: 1.10-1.75]) to fall into the *extreme hospitalization* category than the rest of residents in Richmond.

Certain chronic conditions greatly increased the risk of *extreme hospitalization*: mental health disorders (OR 9.76 [95% CI: 7.99-11.93]), chronic renal failure (OR 6.55 [95% CI: 4.11-10.43]), congestive heart failure (OR 5.72 [95% CI: 4.06-8.07]), COPD and allied conditions (OR 2.50 [95% CI: 1.87-3.33]), ischemic heart disease (OR 2.25 [95% CI: 1.73-2.93]), diabetes (OR 2.23 [95% CI: 1.74-2.86])and arthritis (OR 1.98 [95% CI: 1.53-2.58]).

Co-morbidity was also a strong determinant factor for *extreme hospitalization*. Compared to people with low level of co-morbidity (ADG≤3), patients with higher ADG scores had higher chance of becoming *extreme hospitalization* patients (OR 3.47 [95% CI: 2.30-5.23] for patients with ADG scores between 4 and 6; OR 9.43 [95% CI: 6.28-14.15] for patients with ADG scores of 7 or higher).

Additionally, we have also modeled the outcome event of *extreme hospitalization* against *non hospitalization* (residents who were not hospitalized at all in the year) and *other hospitalization* (hospital patients under 95th percentile of hospital bed days) and summarized the results in Table 5.

Table 5 Odds ratios of factors contributing to extreme hospital use

Population Group	Users	Baseline for Comparison					
		All other residents[2]		Non hospital users[3]		Other hospital patients[4]	
		Sig.[1]	OR (95%CI)[5]	Sig.	OR (95%CI)	Sig.	OR (95%CI)
Sex							
Males	233			-	Baseline		
Females	295			*	0.78 (0.63 – 0.95)		
Age Group							
0 – 44	87	-	Baseline				
45 - 64	100	*	1.42 (1.05 – 1.92)	**	1.52 (1.12 – 2.07)		0.77 (0.56 – 1.05)
65 – 79	156	**	3.90 (2.87 – 5.28)	**	4.29 (3.13 – 5.88)	**	1.70 (1.24 – 2.31)
≥ 80	185	**	9.31 (6.88 – 12.59)	**	11.72 (8.59 – 15.97)	**	3.61 (2.65 – 4.94)
Morbidity and co-morbidities							
ADG I/II (≤ 3 conditions)	38	-	Baseline				
ADG III (4 - 6 conditions)	125	**	3.47 (2.30 – 5.23)	**	3.61 (2.39 – 5.45)		1.07 (0.71 – 1.62)
ADG IV (≥ 7 conditions)	365	**	9.43 (6.28 – 14.15)	**	11.81 (7.86 – 17.77)	**	1.75 (1.17 – 2.60)
Diabetes mellitus	112	**	2.23 (1.74 – 2.86)	**	2.71 (2.07 – 3.56)	**	1.60 (1.24 – 2.07)
COPD and allied conditions	77	**	2.50 (1.87 – 3.33)		3.07 (2.25 – 4.19)		1.95 (1.45 – 2.62)
Ischemic heart disease	115	**	2.25 (1.73 – 2.93)	**	3.32 (2.48 – 4.44)	**	1.45 (1.11 – 1.90)
Congestive heart failure	82	**	5.72 (4.06 – 8.07)	**	15.35 (9.95 – 23.67)	**	3.30 (2.35 – 4.62)
Cancer	104	**	3.55 (2.75 – 4.59)	**	6.63 (5.00 – 8.79)	**	1.79 (1.38 – 2.30)
Chronic renal failure	39	**	6.55 (4.11 – 10.43)	**	18.61 (10.45 – 33.16)	**	3.34 (2.13 – 5.22)
Mental disorder	244	**	9.76 (7.99 – 11.93)	**	11.16 (8.98 – 13.86)	**	7.97 (6.48 – 9.80)
Arthritis	91	**	1.98 (1.53 – 2.58)	**	2.23 (1.68 – 2.95)	**	1.59 (1.22 – 2.08)
Patient Type							
MSOC patients	399	-	Baseline				
Non-MSOC patients	116	**	1.39 (1.10 – 1.75)	**	1.43 (1.12 – 1.83)	*	1.33 (1.05 – 1.70)
Low GP patients	13		1.03 (0.55 – 1.94)		1.11 (0.59 – 2.08)		1.81 (0.94 – 3.48)

1 Sig. = significance – * statistical significant at 0.05 level and ** statistical significant at 0.01 level as compared to baseline

2 Influential factors by importance are CHF, metal disorder, age group, ADG score, cancer, CRF, diabetes, IHD, arthritis and patient type;

3 Influential factors by importance are CHF, ADG score, age group, mental disorder, cancer, CRF, IHD, diabetes, arthritis, sex and patient type;

4 Influential factors by importance are metal disorder, age group, CHF, ADG score, CRF, cancer, diabetes, arthritis, IHD and patient type;

5 OR = odds ratio; 95%CI = 95% confidence interval.

3.7 Excess Hospital Bed Days Attributable to Diabetes

As identified in this report, chronic diseases are strong determinants of hospital utilization. Taking diabetes as an example, we analyzed the utilization pattern for hospital bed days from a chronic disease.

Diabetes is a costly disease in BC. The direct costs for diabetes to B.C.'s health system, including hospitalization, medical services plan and PharmaCare, according to the 2004 BC provincial health officer's annual report[31], are about $1.04 billion in 2003/04. The report further indicates that these costs could increase to $1.9 billion in the following 10 years if the prevalence of diabetes continues to rise at the current rate. However, if prevention initiatives can reduce the incidence of diabetes by just 25 per cent, an annual savings of $200 million could be realized within 10 years.

The reason we discuss diabetes here is that not only is diabetes a complex, serious, and increasingly common chronic disease but also many of the other chronic conditions are often complications from diabetes, particularly not well managed diabetes. In general, most adults with diabetes have at least one co-morbid chronic disease [32] and as many as 40% have three or more co-morbid chronic conditions[33 34]. The complications of diabetes include, among others, stroke, ischemic heart disease, peripheral vascular diseases, neuropathy, end-stage renal disease, blindness and disability.

Excess hospital bed days attributable to diabetes: People with diabetes consumed 8,818[i] hospital bed days. Applying the sex- and age-adjusted hospital rates for people without diabetes to the diabetic population, we found that people with diabetes, if they had not had the disease, would have been expected to stay in hospitals for a total of only 3,236 days. This is 5,582 days less, as compared to the actual number of hospital bed days used by the population. Diabetics aged 65 and older contributed close to 70% of these excess days.

The reasons for excess hospital bed days among Richmond residents with diabetes were wide ranging. In adult groups (aged 20 and over), the excess hospital bed days for individuals with diabetes were mostly for circulatory system diseases. Not surprisingly, the second largest contributor of excess days was diseases in the ICD 10 category of endocrine, nutritional and metabolic diseases, which included diabetes. Other important contributing causes of hospitalization among the population with diabetes included injuries and mental disorder (age 80 and over); respiratory system disease and injuries (age 65 to 79); diseases of nervous system (age 45 to 65) and digestive system diseases (age 20 to 44). For individuals under age 20, two main causes for excess hospital stays were endocrine, nutritional and metabolic diseases and diseases of the blood and blood-forming organs. Excess hospital bed days by age and cause of hospitalization (discharge diagnosis), for people with diabetes, are presented in Table 6.

i Hospitalization related to pregnancy, obstetrics and the associated complications were excluded.

Table 6 Excess hospital bed days among people with diabetes

	People with diabetes		
Causes for Hospitalization	**Actual**	**Expected**	**Excess**
All age groups			
Infectious & Parasitic Diseases	40	9	30
Cancer	344	257	86
Endocrine, Nutritional and metabolic diseases and immunity disorders	772	29	743
Diseases of Blood and Blood-forming Organs	30	17	12
Mental disorders	591	280	311
Diseases of the Nervous System and Sense Organs	358	172	186
Diseases of Circulatory System	2,560	643	1,917
Diseases of Respiratory System	606	217	389
Diseases of Digestive System	652	283	368
Diseases of Genitourinary System	329	124	204
Injury and Poisoning	887	380	507
Diseases of the Skin and Subcutaneous Tissue	59	44	15
Diseases of the Musculoskeletal System and Connection Tissue	184	148	36
Symptoms, Signs and Ill-defined Conditions	537	153	383
Other Causes	872	478	394
Total	**8,818**	**3,236**	**5,582**
Individuals ≥ 80 years of age			
Infectious & Parasitic Diseases	0	2.9	-2.9
Cancer	95.0	52.5	42.5
Endocrine, Nutritional and metabolic diseases and immunity disorders	227.5	8.7	218.8
Diseases of Blood and Blood-forming Organs	2.0	3.9	-1.9
Mental disorders	132.0	60.9	71.1
Diseases of the Nervous System and Sense Organs	32.5	74.6	-42.1
Diseases of Circulatory System	740.5	272.5	468.0
Diseases of Respiratory System	162.0	102.3	59.7
Diseases of Digestive System	137.0	79.5	57.5
Diseases of Genitourinary System	79.0	28.0	51.0
Injury and Poisoning	439.0	190.5	248.5
Diseases of the Skin and Subcutaneous Tissue	19.0	27.7	-8.7
Diseases of the Musculoskeletal System and Connection Tissue	0.0	58.7	-58.7
Symptoms, Signs and Ill-defined Conditions	259.0	73.7	185.3
Other Causes	147.5	135.2	12.3
Total	**2,472**	**1,172**	**1,300**
Individuals 65-79 years of age			
Infectious & Parasitic Diseases	25.5	0	25.5
Cancer	115.5	153.2	-37.7

	People with diabetes		
Causes for Hospitalization	**Actual**	**Expected**	**Excess**
Endocrine, Nutritional and metabolic diseases and immunity disorders	243.0	18.3	224.7
Diseases of Blood and Blood-forming Organs	9.6	6.6	2.9
Mental disorders	165.0	98.8	66.2
Diseases of the Nervous System and Sense Organs	185.0	78.4	106.6
Diseases of Circulatory System	1,199.0	278.9	920.1
Diseases of Respiratory System	345.0	96.7	248.3
Diseases of Digestive System	276.0	119.9	156.1
Diseases of Genitourinary System	164.0	57.1	106.9
Injury and Poisoning	337.5	132.5	205.0
Diseases of the Skin and Subcutaneous Tissue	12.5	11.0	1.5
Diseases of the Musculoskeletal System and Connection Tissue	156.5	67.3	89.2
Symptoms, Signs and Ill-defined Conditions	212.0	56.6	155.4
Other Causes	473.0	247.4	225.6
Total	**3,919.0**	**1,422.7**	**2,496.3**
Individuals 45-64 years of age			
Infectious & Parasitic Diseases	14.0	6.1	7.9
Cancer	110.0	49.4	60.6
Endocrine, Nutritional and metabolic diseases and immunity disorders	250.0	1.5	248.5
Diseases of Blood and Blood-forming Organs	12.5	5.9	6.6
Mental disorders	204.0	99.4	104.6
Diseases of the Nervous System and Sense Organs	139.5	16.3	123.2
Diseases of Circulatory System	499.5	89.3	410.2
Diseases of Respiratory System	98.0	16.6	81.4
Diseases of Digestive System	176.0	78.2	97.8
Diseases of Genitourinary System	72.0	35.6	36.4
Injury and Poisoning	105.5	53.1	52.4
Diseases of the Skin and Subcutaneous Tissue	22.5	4.2	18.3
Diseases of the Musculoskeletal System and Connection Tissue	27.5	20.4	7.1
Symptoms, Signs and Ill-defined Conditions	60.5	20.5	40.0
Other Causes	230.0	90.2	139.8
Total	**2,021.5**	**586.8**	**1,434.7**
Individuals 20-44 years of age			
Infectious & Parasitic Diseases	0.0	0.2	-0.2
Cancer	23.0	1.9	21.1
Endocrine, Nutritional and metabolic diseases and immunity disorders	39.0	0.2	38.8
Diseases of Blood and Blood-forming Organs	0.5	0.7	-0.2
Mental disorders	90.0	20.5	69.5
Diseases of the Nervous System and Sense Organs	1.0	3.0	-2.0

	People with diabetes		
Causes for Hospitalization	**Actual**	**Expected**	**Excess**
Diseases of Circulatory System	120.0	2.6	117.4
Diseases of Respiratory System	1.0	1.5	-0.5
Diseases of Digestive System	61.5	5.7	55.8
Diseases of Genitourinary System	13.5	3.3	10.2
Injury and Poisoning	3.0	3.9	-0.9
Diseases of the Skin and Subcutaneous Tissue	5.0	0.6	4.4
Diseases of the Musculoskeletal System and Connection Tissue	0.0	2.0	-2.0
Symptoms, Signs and Ill-defined Conditions	5.0	2.3	2.7
Other Causes	21.5	4.6	16.9
Total	**384.0**	**52.9**	**331.1**
Individuals < 20 years of age			
Infectious & Parasitic Diseases	0.0	0.0	0.0
Cancer	0.0	0.0	0.0
Endocrine, Nutritional and metabolic diseases and immunity disorders	12.5	0.0	12.5
Diseases of Blood and Blood-forming Organs	5.0	0.0	5.0
Mental disorders	0.0	0.5	-0.5
Diseases of the Nervous System and Sense Organs	0.0	0.1	-0.1
Diseases of Circulatory System	1.0	0.1	0.9
Diseases of Respiratory System	0.0	0.3	-0.3
Diseases of Digestive System	1.0	0.2	0.8
Diseases of Genitourinary System	0.0	0.1	-0.1
Injury and Poisoning	2.0	0.3	1.7
Diseases of the Skin and Subcutaneous Tissue	0.0	0.0	0.0
Diseases of the Musculoskeletal System and Connection Tissue	0.0	0.1	-0.1
Symptoms, Signs and Ill-defined Conditions	0.0	0.1	-0.1
Other Causes	0.0	0.0	0.0
Total	**21.5**	**1.9**	**19.6**

Sex difference in excess hospital bed days attributable to diabetes: Table 7 shows that there are sex differences in the number of hospital bed days used by residents with diabetes. Overall, women with diabetes appear to have used more hospital bed days as compared to men with diabetes. The differences are especially obvious in the older age groups. Women with diabetes aged 80 and over consumed more hospital bed days due to circulatory system diseases (94 excess days per 100 patients as compared to men with diabetes), endocrine, nutritional and metabolic diseases (48 excess days per 100 patients), and mental disorder (41 excess days per 100 women versus none in men). Men with diabetes, however, consumed more hospital bed days due to injury and poisoning as compared to women with diabetes.

Table 7 Sex Differences in excess hospital bed days attributable to diabetes

Sex Difference (days for women – days for men) per 100 People		
Causes for Hospitalization	**Without Diabetes**	**With Diabetes**
All age groups		
Infectious & Parasitic Diseases	-1.4	-3.3
Cancer	-18.0	22.0
Endocrine, Nutritional and metabolic diseases and immunity disorders	1.0	90.3
Diseases of Blood and Blood-forming Organs	-0.6	29.8
Mental disorders	0.2	90.7
Diseases of the Nervous System and Sense Organs	-11.5	5.8
Diseases of Circulatory System	-25.6	21.8
Diseases of Respiratory System	-6.0	38.6
Diseases of Digestive System	-4.1	11.5
Diseases of Genitourinary System	-0.9	18.3
Injury and Poisoning	22.8	-39.4
Diseases of the Skin and Subcutaneous Tissue	-2.7	0.1
Diseases of the Musculoskeletal System and Connection Tissue	4.4	6.9
Symptoms, Signs and Ill-defined Conditions	-3.5	9.9
Other Causes	12.1	36.9
Total	**-33.7**	**340.0**
Individuals ≥ 80 years of age		
Infectious & Parasitic Diseases	-1.2	0.0
Cancer	-9.8	11.4
Endocrine, Nutritional and metabolic diseases and immunity disorders	-0.3	48.5
Diseases of Blood and Blood-forming Organs	-0.4	-0.8
Mental disorders	-2.3	41.1
Diseases of the Nervous System and Sense Organs	-11.1	2.3
Diseases of Circulatory System	-12.2	93.7
Diseases of Respiratory System	-5.2	11.3
Diseases of Digestive System	-2.8	-13.9
Diseases of Genitourinary System	-2.7	11.1
Injury and Poisoning	20.7	-19.1
Diseases of the Skin and Subcutaneous Tissue	-3.0	2.4
Diseases of the Musculoskeletal System and Connection Tissue	3.7	0.0
Symptoms, Signs and Ill-defined Conditions	-3.4	17.4
Other Causes	5.9	30.3
Total	**-24.4**	**235.7**
Individuals 65-79 years of age		
Infectious & Parasitic Diseases	0.0	-2.4
Cancer	-7.8	5.6

Sex Difference (days for women – days for men) per 100 People		
Causes for Hospitalization	**Without Diabetes**	**With Diabetes**
Endocrine, Nutritional and metabolic diseases and immunity disorders	1.2	9.2
Diseases of Blood and Blood-forming Organs	-0.1	-0.1
Mental disorders	2.8	-0.4
Diseases of the Nervous System and Sense Organs	-0.7	-5.2
Diseases of Circulatory System	-10.2	-21.8
Diseases of Respiratory System	-0.4	21.4
Diseases of Digestive System	-0.7	9.9
Diseases of Genitourinary System	-0.2	2.6
Injury and Poisoning	3.4	-14.1
Diseases of the Skin and Subcutaneous Tissue	0.6	1.2
Diseases of the Musculoskeletal System and Connection Tissue	0.5	7.2
Symptoms, Signs and Ill-defined Conditions	-1.2	-10.7
Other Causes	2.8	-12.3
Total	**-10.1**	**-10.0**
Individuals 45-64 years of age		
Infectious & Parasitic Diseases	-0.3	-0.9
Cancer	-0.6	0.0
Endocrine, Nutritional and metabolic diseases and immunity disorders	0.0	11.0
Diseases of Blood and Blood-forming Organs	-0.1	1.1
Mental disorders	0.2	12.1
Diseases of the Nervous System and Sense Organs	0.4	8.7
Diseases of Circulatory System	-2.4	-12.2
Diseases of Respiratory System	-0.3	6.3
Diseases of Digestive System	0.1	1.8
Diseases of Genitourinary System	1.3	3.4
Injury and Poisoning	-0.8	1.6
Diseases of the Skin and Subcutaneous Tissue	-0.2	-1.5
Diseases of the Musculoskeletal System and Connection Tissue	0.1	-0.25
Symptoms, Signs and Ill-defined Conditions	0.5	2.0
Other Causes	2.0	9.9
Total	**-0.2**	**42.9**
Individuals 20-44 years of age		
Infectious & Parasitic Diseases	0.1	0.0
Cancer	0.1	4.8
Endocrine, Nutritional and metabolic diseases and immunity disorders	0.1	0.2
Diseases of Blood and Blood-forming Organs	0.2	0.2
Mental disorders	-0.7	38.0
Diseases of the Nervous System and Sense Organs	-0.2	0.0

Sex Difference (days for women – days for men) per 100 People		
Causes for Hospitalization	**Without Diabetes**	**With Diabetes**
Diseases of Circulatory System	-0.6	-33.3
Diseases of Respiratory System	0.1	-0.4
Diseases of Digestive System	-0.6	13.0
Diseases of Genitourinary System	0.7	1.2
Injury and Poisoning	-0.8	1.6
Diseases of the Skin and Subcutaneous Tissue	0.1	-1.9
Diseases of the Musculoskeletal System and Connection Tissue	0.2	0.0
Symptoms, Signs and Ill-defined Conditions	0.5	1.3
Other Causes	1.4	9.1
Total	**1.2**	**33.5**
Individuals < 20 years of age		
Infectious & Parasitic Diseases	0.0	0.0
Cancer	0.1	0.0
Endocrine, Nutritional and metabolic diseases and immunity disorders	0.0	21.4
Diseases of Blood and Blood-forming Organs	0.0	29.4
Mental disorders	0.2	0.0
Diseases of the Nervous System and Sense Organs	0.1	0.0
Diseases of Circulatory System	0.0	-4.5
Diseases of Respiratory System	-0.2	0.0
Diseases of Digestive System	-0.1	0.7
Diseases of Genitourinary System	0.0	0.0
Injury and Poisoning	-0.4	-9.1
Diseases of the Skin and Subcutaneous Tissue	-0.1	0.0
Diseases of the Musculoskeletal System and Connection Tissue	0.0	0.0
Symptoms, Signs and Ill-defined Conditions	0.2	0.0
Other Causes	0.0	0.0
Total	**-0.3**	**37.8**

Avoidable hospital bed days by reducing a portion of diabetic prevalence: Diabetes is a preventable disease. If the current public health initiatives in BC effectively prevented chronic diseases, 10%, 25% and 50% reductions of diabetic prevalence by 2003/04 rate could reduce hospital use by 558, 1,396 and 2,791 days, respectively among Richmond residents by applying the corresponding sex- and age-adjusted hospital rates to the virtually revised diabetic and non-diabetic populations.

3.8 Excess Hospital Bed Days Attributable to Diabetes with Co-Morbidity

As identified previously, co-morbidity is a strong determinant of hospital utilization. In particular, people with diabetes are more vulnerable to a range of mental disorders[35]. Depression and anxiety are more common in people with diabetes than in the general population[36 37 38 39]. We present in this report the pattern of hospital care utilization when both diabetes and mental disorder are present. We show that hospital use from mental disorder is greatly increased when diabetes was present.

Interaction between diabetes and mental disorder: Table 8 shows that the interaction between diabetes and mental disorder can lead to excess days of hospital stay. Having both diabetes and mental disorder can significantly prolong the average length of stay. People with mental disorder but without diabetes, on average, stayed only 9.4 days longer than hospital patients without mental illness. Adding diabetes to mental illness results in, on average, extra 15.6 days a year in hospital stay compared to hospital patients without mental illness. Similarly, excess hospital stay was 2.7 days for people with diabetes but without mental disorder and 8.9 days for people with diabetes and mental disorder. It may be that coping with both mental illness and diabetes (or another chronic disease) at the same time demands a level of personal capacity and self efficacy far beyond what the sufferer can muster. This combination of "concurrent" disorders can benefit from further exploration with respect to the optimal support structure and strategies that would improve patient quality of life, health outcomes, and decreased reliance on hospital based care.

Interaction between diabetes and other co-morbidities: Table 8 also listed chronic conditions whose interactions with diabetes were observed, including hypertension, chronic obstructive pulmonary disease, some circulatory system diseases excluding ischemic heart disease and chronic renal failure. However, we did not find any obvious difference in hospital bed days due to cancer, ischemic heart disease and arthritis between populations with and without diabetes.

Table 8 Differences in the Rates of Hospital Bed Days by Diabetics and Co-Morbidity

Diabetes	Co-Morbidity	Hospital Bed Days	Hospital Patients	Days /person	Difference by co-morbidity
Mental disorder					
Non-diabetes	No	24775.5	8208	3.0	9.4
	Yes	13872.5	1118	12.4	
Diabetes	No	5810.5	1020	5.7	15.6
	Yes	3007.5	141	21.3	
Hypertension					
Non-diabetes	No	30012.5	7691	3.9	1.4
	Yes	8635.5	1635	5.3	
Diabetes	No	4877.5	771	6.3	3.8
	Yes	3940.5	390	10.1	
Chronic Obstructive Pulmonary Disease (COPD) and allied conditions					
Non-diabetes	No	34156	8780	3.9	4.2
	Yes	4492	546	8.2	
Diabetes	No	7639	1077	7.1	6.9
	Yes	1179	84	14.0	
Circulatory System Disease					
Non-diabetes	No	18417.5	5993	3.1	3.0
	Yes	20230.5	3333	6.1	
Diabetes	No	1610.5	452	3.6	6.6
	Yes	7207.5	709	10.2	
Congestive Heart Failure					
Non-diabetes	No	35399.5	9126	3.9	12.4
	Yes	3248.5	200	16.2	
Diabetes	No	6787	1067	6.4	15.2
	Yes	2031	94	21.6	
Chronic Kidney Failure					
Non-diabetes	No	37276	9225	4.0	9.5
	Yes	1372	101	13.6	
Diabetes	No	7480.5	1095	6.8	13.4
	Yes	1337.5	66	20.3	

Discussion

This study quantitatively demonstrated the impact of chronic health conditions, co-morbidity, age, and MSOC (majority source of care) physicians on *hospitalization* and *extreme hospitalization*. The results affirm the importance of population based chronic disease prevention and coordinated individual case management across the service continuum.

Hospitalization is strongly associated with chronic health conditions. Indeed, the Richmond population with the lowest level of morbidity, which accounted for 21 percent of total, only used 1.8 percent of the hospital bed days in the fiscal year. In contrast, the other 79 percent of the population, which had one or more chronic health conditions, utilized more than 98 percent of the hospital bed days.

The major chronic health conditions that resulted in hospital care were circulatory system diseases, chronic renal failure, mental disorder, COPD and allied conditions, cancers, diabetes, and arthritis. As the degree of co-morbidity increased, the risk of *hospitalization* and risk of *extreme hospitalization* grew dramatically. We noted that a great majority of those top five percent users (*extreme hospitalization*) were patients with highly complex chronic health conditions. Our results confirmed the importance of improving care management for people with multiple morbidities across the health system. In addition, we found that non-MSOC patients had higher odds of being hospitalized and being among those 5% *extreme hospitalization* users. These findings support the goals of the BC Primary Health Care Charter to improve the capacity of primary care in BC, specifically the importance of supporting MSOC physicians and enhancing coordinated care management for patients with multiple morbidities.

We observed differences in population age and ethno-cultural composition amongst the five neighbourhood areas: older and sicker population in Blundell and relatively younger ethno-cultural population in East Richmond. Nevertheless, neighbourhood area still stood out to be an independent determinant of *hospitalization* even when age, sex and disease conditions were adjusted in the statistical models. Assuming that other areas of Richmond had the same age and ACG (health resource dependency) structure as those in East Richmond (one of the two neighbourhoods with lowest average family income in Richmond), a 12.8% of reduction in hospital bed days for Richmond could be achieved, if the neighbourhood differences in hospital utilization were eliminated. Inequality of utilization by place of residence suggests that socio-economic inequity may exist in our healthcare system. Our finding here may be a reflection of differences in socio-economic status, immigrant and ethno-cultural effect[40], language barrier to receive care, availability and accessibility of health care and social supports in neighbourhood area, and other infrastructural factors amongst neighbourhoods. The Integrated Neighbourhood Network project currently underway in Richmond is examining these issues for the Blundell neighborhood.

We showed the direct burden of diabetes on hospital utilization and excess hospital bed days for people with diabetes by age and sex groups. The study demonstrated the significant impact of diabetes alone as well as with co-morbid mental disorder on hospital utilization. According to the self-reported data on prevalence rates of diabetes in 2005 from the Canadian Community Health Survey[41], Richmond ranked the second best out of the 16 health service delivery areas in BC and BC ranked the third best amongst the ten provinces in Canada. Thus the hospital burden on diabetes-related care in BC and in Canada is likely to be much higher than what we found in Richmond.

Our study had some limitations. One limitation was that socio-economic status, an important determinant of both personal health and care utilization, was not available at the individual level. We could neither analyze its direct contribution to hospitalization nor adjust for its influence on the other risk factors for hospitalization. While our analysis points to neighborhood level influences on health care usage, the neighborhood units that we used are still large in size, and may have masked differences between smaller sub areas within them. We are hopeful that challenges from confidentiality and privacy protection could be resolved to permit future analyses at smaller spatial units, for example at the municipality planning area or the Census Dissemination Area levels.

We also note that administrative databases are subject to a number of sources of errors, including but not limited to coding errors in diagnosis, in place of residence, and in other demographic information. However, such errors were likely to apply equally across geography, age, and sex.

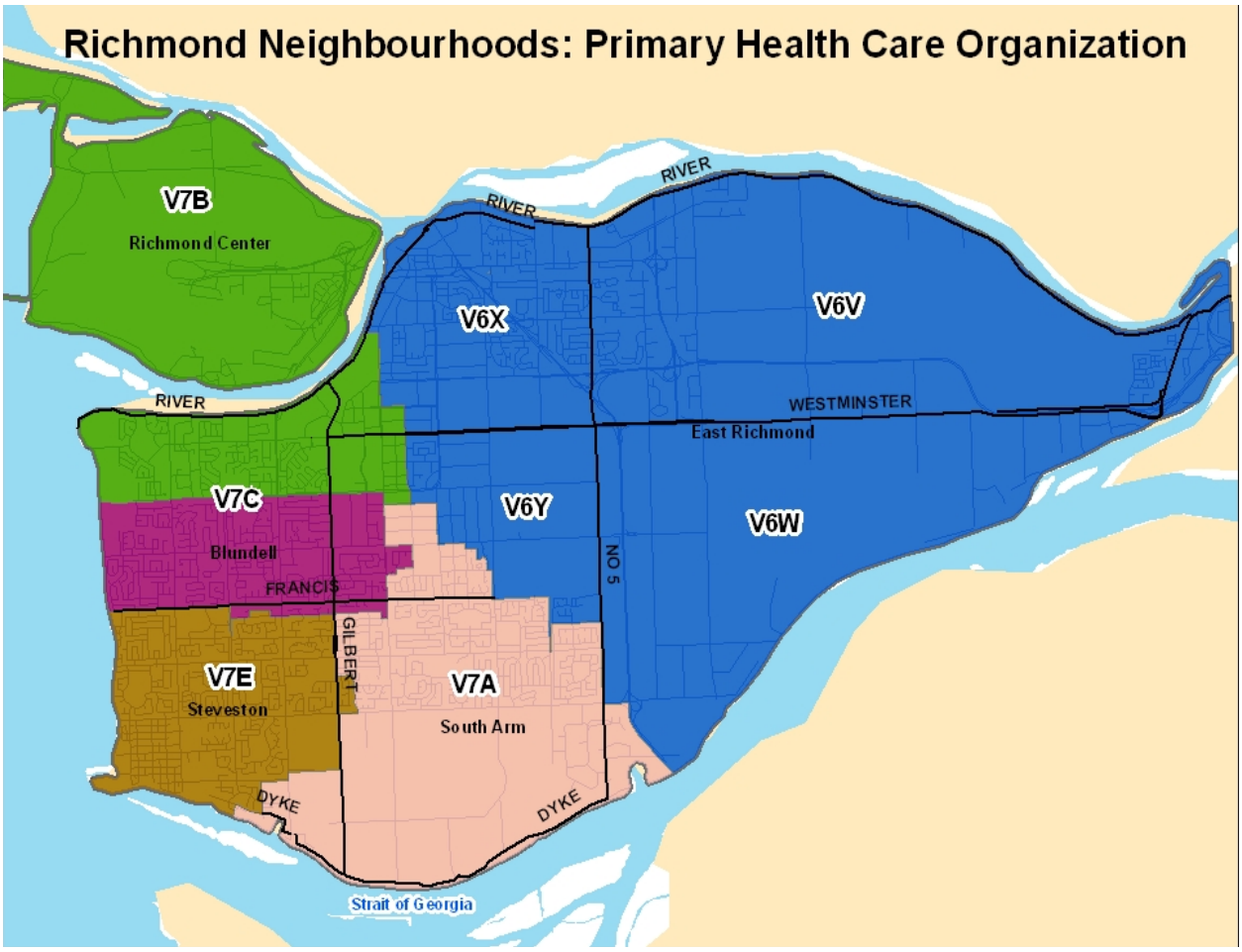
We studied the health care use experience of residents in an urban and ethno-culturally diverse community. Our findings support the need for a complex care management system. They also affirm the current policy direction of Vancouver Coastal Health, Provincial Health Services Authority and the BC Ministry of Health toward improving primary health care in the region and the province.

Appendices

Appendix I: A Brief Description of the Five Neighbourhoods in Richmond

For primary health care planning purposes, Richmond health services delivery area (HSDA) is divided into five neighbourhoods of roughly equal populations. They are South Arm, Richmond Centre, Blundell, Steveston and East Richmond as shown in Figure 1.

Figure 1 City of Richmond and its Five Neighbourhood Areas



Based on the 2001 Census data, population characteristics were summarized in Table 9.

Table 9 Major population characteristics for Richmond and its five neighbourhoods

Population Group	South Arm	Richmond Centre	Blundell	Steveston	East Richmond	Total
Population						
Total population	32,755	32,070	33,205	33,685	32,605	164,320
Percent of seniors	12%	13%	15%	10%	9%	12%
Percent of visible minority	56%	64%	58%	48%	69%	59%
Percent of immigrants	52%	60%	55%	45%	57%	30%
Mobility						
Percent of total movers age 5+ within the previous 5 years	42%	58%	44%	38%	46%	45%
Percent of newly arrived immigrants age 5+ within 5 years	11%	21%	15%	10%	11%	13%
Income						
Average family income	$66,105	$54,777	$60,784	$72,131	$54,789	$62,736
Percent of low income families (age 15+)	22%	31%	25%	17%	24%	24%
Education						
Percent of education at high school or lower (age 20+)	21%	18%	18%	19%	21%	19%
Percent of education at university or higher (age 20+)	33%	38%	37%	36%	31%	35%
Housing Cost						
Average gross rent in dollars	$775	$827	$850	$613	$843	$771
Percent of renters spending > 30% of household income on gross rent	46%	47%	43%	36%	38%	43%
Average value of dwelling in dollars	$278,871	$229,795	$297,456	$301,355	$285,153	$280,540
Percent of owners spending > 30% of household income on owner's major payments	25%	30%	25%	20%	35%	27%
Family Structure						
Percent of married/common families	81.3%	78.9%	79.9%	80.2%	80.6%	80.2%
Percent of lone parents in families with children	19%	23%	21%	19%	20%	20%
Average number of children per census family	1.23	1.07	1.23	1.35	1.27	1.24

Percentages are subject to rounding errors and may not add up to the total.

Overall about 60% of the Richmond residents are "visible minorities". However, the Richmond population is not homogeneous. The proportions of visible minorities range from 48% in Steveston to 69% in East Richmond. Richmond Center has the highest proportion of ethnic Chinese at 46% of the neighbourhood population, while East Richmond has the highest ethnic South Asian at 16%.

In terms of age, the Blundell area has the highest percentage of people aged 65 and over (15%). The populations in Steveston and East Richmond are younger compared to other neighbourhoods.

Richmond Center has the largest proportion of residents living in low-income households (31% of age 15+ population). Richmond Center also has the highest proportion of "movers", with 58% of the population

over age 5, having moved at least once in the previous five years. 21% of those living in Richmond Center immigrated from outside Canada in the previous five years.

This is in contrast to Steveston, where only 17% of the residents aged 15 and over live in low-income households and 38% aged 5 and over lived in a different address in the previous five years. Though Richmond Centre is the least expensive area in Richmond, renting cost relative to family income is the highest.

Appendix II: Methods Used to Estimate Excess Hospital Bed Days

The excess hospital bed days for people with a characteristic of interest are measured by the difference between their observed and expected hospital use. The observed number of hospital bed days can be obtained directly from their utilization records and the expected number of hospital bed days is calculated from the utilization rates of the population without the characteristic of interest. In estimating excess hospital bed days between people with different disease status, the expected values were generated from the non-disease group where age and sex were adjusted. Socioeconomic factor could be controlled as well if the information is available. This made the two populations comparable except disease status as did by Olveira-Fuster and etc.[28] and Currie and etc.[29]. We used this method to estimate excess hospital bed days for people with diabetes. However, if we compare two populations by social or geographic factors instead of disease, disease patterns for the two populations must be adjusted by introducing a case mix score, such as ACG by Sullivan and etc.[30]. This method was adopted in this study to compare MSOC patients and non-MSOC patients as well as the five neighbourhood areas.

Some Examples:

Excess hospital bed days by non-MSOC patients: age groups in five categories (0-24, 25-44, 45-64, 65-79 and 80 and older) and health resource-dependency scores expressed as 83 ACG classes in this study were used to calculate expected hospital bed days for non-MSOC patients. Assuming b_{ij} refers to the average hospital bed days per person in MSOC patients in age group *i* and ACG category *j*, where *i* ranges from 1 to 5 and *j* from 1 to 83 and, similarly, p_{ij} as the population size of non-MSOC patients in age group *i* and ACG category *j*, we have

$$\text{Expected hospital bed days for non-MSOC patients} = \sum_i \sum_j (b_{ij} * p_{ij}) \qquad (1)$$

where $\sum_i \sum_j$ is the sum across all *i*'s and *j*'s. Subtracting from the observed hospital bed days for non-MSOC patients provides an estimate of excess hospital bed days used by the non-MSOC patients.

Excess hospital bed days by people with diabetes: Since diabetes as a health variable is the characteristic of interest that defines the population under comparison, it was inappropriate to include any health resource-dependency scores in the determinant specification. In this case, the five age groups and sex were adopted to determine the expected hospital bed days for people with diabetes if the disease with its complications was eliminated. Assuming d_{ik} refers to as average hospital bed days per person in people without diabetes in *i*th age group and *j*th sex category, where *i* range from 1 to 5 (5 age groups) and *j* is either 1 or 2 (male or female) and q_{ik} represents the population size of people with diabetes in age group i and sex category *j*, we have

$$\text{Expected hospital bed days for people with diabetes} = \sum_i \sum_k (d_{ik} * q_{ik}) \qquad (2)$$

Subtracting from the observed hospital bed days for people with diabetes provides an estimate of excess hospital bed days for people with diabetes.

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