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Residence, income and cancer hospitalizations in British Columbia during a decade of policy change

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Abstract

Background: Through the 1990s, governments across Canada shifted health care funding allocation and organizational foci toward a community-based population health model. Major concerns of reform based on this model include ensuring equitable access to health and health care, and enhancing preventive and community-based resources for care. Reforms may act differentially relative to specific conditions and services, including those geared to chronic versus acute conditions. The present study therefore focuses on health service utilization, specifically cancer hospitalizations, in British Columbia during a decade of health system reform.

Methods: Data were drawn from the British Columbia Linked Health Data resource; income measures were derived from Statistics Canada 1996 Census public use enumeration area income files. Records with a discharge (separation) date between 1 January 1991 and 31 December 1998 were selected. All hospitalizations with ICD-9 codes 140 through 208 (except skin cancer, code 173) as principal diagnosis were included. Specific cancers analyzed include lung; colorectal; female breast; and prostate. Hospitalizations were examined in total (all separations), and as divided into first and all other hospitalizations attributed to any given individual. Annual trends in age-sex adjusted rates were analyzed by joinpoint regression; longitudinal multivariate analyses assessing association of residence and income with hospitalizations utilized generalised estimating equations. Results are evaluated in relation to cancer incidence trends, health policy reform and access to care.

Results: Age-sex adjusted hospitalization rates for all separations for all cancers, and lung, breast and prostate cancers, decreased significantly over the study period; colorectal cancer separations did not change significantly. Rates for first and other hospitalizations remained stationary or gradually declined over the study period. Area of residence and income were not significantly associated with first hospitalizations; effects were less consistent for all and other hospitalizations. No interactions were observed for any category of separations.

Conclusions: No discontinuities were observed with respect to total hospitalizations that could be associated temporally with health policy reform; observed changes were primarily gradual. These results do not indicate whether equity was present prior to health care reform. However, findings concur with previous reports indicating no change in access to health care across income or residence consequent on health care reform.

Background

Through the 1990s, provincial and territorial governments across Canada shifted health care funding allocation and organizational foci toward a community-based population health model. Similar strategies were invoked in most provinces across Canada. The population health model recognizes that individual and population health are affected by social, cultural and environmental, as well as biological, factors [4-8]. Social and economic inequalities that accompany location within a stratified social structure are accorded particular importance (for example, [9]). As a result, dominant foci of health reform based on the population health model include ensuring equitable access to health and health care among groups differentiated by such factors as income, rural-urban residence, gender and race/ethnicity, as well as enhancing preventive and community-based resources for care.

In 1990, the government of British Columbia established the Royal Commission on Health Care and Costs to review the provincial health care system and make recommendations for change. Its report, entitled "Closer to Home" [1] recommended development of regional (decentralized) management and delivery of health services. In response, the BC Ministry of Health outlined its plans for the future as "New Directions for a Healthy British Columbia" [2]. This document outlined directions for reform and associated priorities, which included development of specific health policy frameworks to address obstacles to equitable service and health status, and bringing health care closer to home, through enhancing local management and provision of services in peoples' homes, local communities, and regions. Recommendations from "New Directions" were formally enacted through the Health Authorities Act, proclaimed in 1993. The government subsequently modified its approach to regionalization in 1996, detailed in a report entitled "Better Teamwork, Better Care" [3]. The focus of health care reform was narrowed, specifically toward improving health care services. Amendments to the Health Authorities Act were legislated in 1997.

The extent to which structural changes directed towards implementing the population health model will shift focus and resources consistent with the objectives of health reform remains unclear. To adequately assess the impact of health reform on equity, Brownell et al. [10] assert that "tracking the impact ... on society's most vulnerable groups, those with the worst health status, is critical" (p.658). The net effects of reform, positive or negative, can be expected to be greatest within these groups. Hertzman et al. [11] note that geographic location provides a basis for understanding differences in health, and older adults and those with low socio-economic status (SES) are repeatedly found to be vulnerable groups at high risk for poor health and heavy use of health services [12].

To date, research on the implications of health care reform for reducing inequities in health and health care associated with social location (SES, age, sex, etc.) has focused on the impact of hospital bed closures on utilization rates. Findings so far suggest little change in access to care. For example, Carriere et al. [13] examined changes in hospital utilization rates across neighbourhood income quintiles before and after reductions in the supply of acute hospital care beds in Manitoba. Differences in utilization across income quintiles remained stable, despite declines in inpatient surgery, increases in outpatient surgery, and declines in hospital bed days. Brownell et al. [10] report similar findings, concluding that vertical equity had not been affected by bed closures. "... [W]e have provided strong evidence of a reformed system delivering care more efficiently ... and preserving equity by providing relatively more care to those groups who are sicker and more vulnerable" (p.667).

Research findings in other provinces also indicate little change in utilization. For example, Liu et al. [14] addressed the impact of fifty-two rural hospital closures in Saskatchewan (in 1990) on several factors, including the health status of rural residents. They found closures did not adversely affect rural residents' health status or access to inpatient hospital services. Shortt and Shaw [15] found no difference in waiting period to elective surgery between those in higher *vs*. lower socio-economic status groups during a period of health reform and hospital restructuring in Ontario. Following Brownell et al. [10], Shortt and Shaw report that efficiency via hospital reform "does not appear to have been purchased at the price of equity" (p.415).

Reforms may act differentially relative to specific conditions and services, including those geared to chronic versus acute conditions. The present study therefore focuses on health service utilization, specifically cancer hospitalizations, in British Columbia during a decade of health system reform. Cancer is the most frequent cause of death in Canada; cancer hospitalizations ranked sixth in Canadian separations in 2001–2002 [16]. By its nature, cancer disproportionately affects older individuals. North America has the highest worldwide cancer prevalence, at 1.5%, or approximately 3.2 million people [17]. Prevalence will increase as detection and treatment improve.

Cancer incidence is associated with low socio-economic status (SES) in both the United States and Canada [18-20]. Mackillop et al. [21] compared the relationship between income and cancer incidence in Canada (Ontario Cancer Registry) and the United States (Surveillance, Epidemiology and End Result (SEER) Registry). Their results indicated that the association routinely present in the US occurs as well in Ontario, that is, "poorer Canadians differ from richer Canadians in the same ways as poorer Americans differ from richer Americans" (p. 909).

Low SES is also associated with late-stage cancer diagnosis and shorter survival [United States: [22,23]; Canada: [24,25]; other countries: [26-29]; but see also [30], and discussion below]. In addition, survival time from diagnosis displays regional variation [31-33]. Farrow, Samet and Hunt [31] report the observed US differential was not explained by stage at presentation or treatment received. Treatment itself may be associated with SES and rural-urban residence [23,34]. For example, Paszat et al. [35] examined radiotherapy rates for breast cancer in Ontario across years (1982 – 1991), age and socioeconomic factors and found that radiotherapy within one year of diagnosis varied by region, age and income.

Gorey et al. [36-40] found consistent evidence that the universal health coverage enjoyed by Canadians results in an attenuation of the SES survival differential observed in the United States, such that relatively poor Canadians experienced increased survival over their US counterparts. The authors note their findings are consistent with explanations that cite an association between health care system and disease prevention and treatment.

In summary, health care reforms predicated on a population health model are designed to affect health service distribution, delivery and outcome among Canada's population, and for the better. However, the extent to which structural changes succeed in shifting both focus and resources toward the objectives of health reform remains unclear. Further, changes designed to improve efficiency have considerable potential to harm equity in health service delivery [41]. Research conducted to date indicates differences in hospital utilization across SES groups remain unchanged, suggesting access has not been affected by health care reform. However, maintenance of the *status quo* is not the same as positive change, and an acknowledged objective of health reform is to increase equity of access to health care and health status.

With respect to cancer, the literature demonstrates significant relationships between area of residence, socio-economic status (both individual and community) and cancer incidence, survival, and, in some cases, treatment. Stage at diagnosis varies with socio-economic status in some locations. Between-country differences in health system organization, specifically between Canada and the United States, are implicated in observed differential survivorship. In general, Canadians with cancer face attenuated differentials with respect to SES and residence in comparison to Americans. However, differentials appear to exist within the Canadian context, and it is therefore important to understand the effect, if any, of health system change on cancer diagnosis, treatment, health care utilization, and survival patterns.

Through the 1990s in British Columbia there were three designs for health administrative systems (prior to 1993; 1993–1996; 1997 and after), with two legislative changes, predicated on two related government reports. Should the effects of government health reform be treated analytically as a process, expected to produce gradual changes in system indicators in a given direction, or as a single event or sequence of events, expected to produce dichotomous changes before and after implementation? As the events described happened more or less continuously, and administrative systems were restructured, only to be restructured again more or less immediately, we argue that the decade should be treated as a decade of continuous policy change.

From the perspective of data at the level of individual hospitalizations, top-level administrative restructuring may or may not engender effects, and a temporal association of changes in policy and hospitalization trends can be tested statistically. In this paper we examine trends in hospitalization throughout the decade with respect to cancer. We approach the analysis from both dichotomous and sequential perspectives. Joinpoint regression allows us to ask whether discontinuities are evident in event rates over time. Due to data limitations (data span only eight calendar years), we test simply whether there is evidence for one discontinuity over the time period. In addition, using generalized estimating equations, we examine potential determinants of event counts, including hospitalization year as one of the variables.

We ask two questions. First, do hospitalization rates display discontinuities over the study period consistent with the timing and intent of health care reform? Second, are there significant associations of area of residence, income quintile or hospitalization year, or interactions of these variables, with hospitalization rates?

In regard to the first question, we examine whether utilization trends are consistent across the decade, or dichotomous coincident with policy changes. Rates for aggregate cancer hospitalizations, as well as for specific cancers (lung, colorectal, breast and prostate) are assessed. In addition, first and other (subsequent) hospitalization rates are assessed separately. First hospitalization represents the first event for any one individual; other represents second and higher count hospitalizations with respect to that individual. All (total), first and other hospitalizations are assessed with respect to all cancers and the specified four cancers. Alternative explanations must be evaluated with respect to disease incidence patterns, which determine demand for services. We use first hospitalization as a proxy measure for cancer incidence, and evaluate whether all and other hospitalizations vary with first hospitalizations, or disparately. It is important to note that variation observed may be the result of changes in treatment patterns as well as policy.

With respect to the second question, we analyse whether there are significant associations of cancer hospitalization rates with area of residence, income quintile, year of hospitalization, and area by year, quintile by year, and area-income-year interactions. Focusing on the effect of health care reform over time on potential inequities in health care, we assess the significance of area of residence, area income quintile, hospitalization year, and their interactions, and whether they display a consistent pattern with respect to all, first or other hospitalizations.

Methods

Data were drawn from the British Columbia Linked Health Data (BCLHD) resource, an administrative health data repository including hospital separations, physician services, continuing care, vital statistics and other services [42]. These data are accessible through the British Columbia Ministry of Health; the resource is compiled and distributed to researchers by the University of British Columbia Centre for Health Services and Policy Research Health Information Development Unit. Use of the BCLHD was approved by BC Ministry of Health, BCLHD Data Stewards and the University of Victoria Human Research Ethics Committee.

The data represent a 10% random sample of service users from British Columbia over fiscal years 1990–1991 through 1998–1999. Hospital separations records were analyzed. A separation record is generated each time an individual is discharged from hospital, whether treated as an in- or out-patient. Records with a separation date between 1 January 1991 and 31 December 1998 were selected for this study.

All records with ICD-9 codes 140 through 208 as the principal diagnosis (except skin cancer, ICD-9 173) were included in the analysis. This criterion conforms to that used in Canadian Cancer Statistics reported by the National Institute of Cancer [43]. Specific cancers analyzed include lung (ICD-9 162); colorectal (ICD-9 153–154); female breast (ICD-9 174); and prostate (ICD-9 185). Individuals were assigned annually to eight age categories as follows: 0–19 years, 20–29, 30–39, 40–49, 50–59, 60–69, 70–79 and 80+, again as reported in the Canadian Cancer Statistics.

All separations constitute all records for the designated time period, and include multiple separations attributed to a single individual. First separations designate the initial appearance of a patient identifier in the dataset, and include only this separation; other separations represent second and higher count hospitalizations with respect to an individual. First separations were defined beginning April 1990, hence 1991 data do not include an unusual surge of first separations consequent on being the first year in the data set. First hospitalization *per* individual may act as a proxy incidence measure, reasoning that an individual diagnosed with cancer will be treated at a hospital at least once over the course of their disease. Total study period counts for all, first and other separations, by cancer, are reported in Table 1.

Area of residence was defined by household location within the boundaries of either a Community Health Service Society (CHSS) area, or a Regional Health Board (RHB). These were geographically distinct administrative units used for health care planning and delivery under health care reforms implemented through the 1990s. There were eleven Regional Health Boards and seven Community Health Service Societies within the province. In general, CHSSs were less densely populated and more rural than RHBs, which contained the major cities in the province.

Table 1: Frequency counts for all and specific cancers, all, first and other separations, totalled over the study period (1991–1998).

Cancer (ICD-9)	Frequency (count)		
	all separations	first separations	other separations
All (ICD-9 140 through 208, except 173)	22,312	11,752	10,560
Lung (ICD-9 162)	2,751	1,440	1,311
Colorectal (ICD-9 153–154)	2,325	1,425	900
Female Breast (ICD-9 174)	2,625	1,694	931
Prostate (ICD-9 185)	2,465	1,629	836

Individual income is not included in the BCLHD resource. We utilized mean household income within enumeration areas derived from 1996 Canadian Census public use data, with income quintile rankings subsequently assigned to individuals using postal code information. Income quintiles here are therefore ecological rather than individual measures. Although not ideal [44], census data provide us with the opportunity to estimate an association between SES and cancer hospitalizations.

Data sets were maintained and summary statistics generated using SAS version 8.00 [45]. Age-sex standardized separations rates and associated 95% confidence intervals were calculated using the Manitoba SAS rates macro [46]. Rates were calculated using 1991–1998 BC population data sets [47], with the BC 1991 population as a standard. Reference data sets were compiled for mid-year provincial populations. Breast and prostate cancer rates were calculated using only female or male population structures respectively.

Annual trends in age-sex adjusted rates were analyzed by joinpoint regression [48], which assesses the minimum necessary number of discontinuities, termed joinpoints, to adequately describe a sequence of rates over time. Analyses assumed a log-linear model and tested whether the pattern of rates over time were best described by a straight line (no joinpoints, JP0), or whether a single point of change (JP1) in trend was required.

Longitudinal multivariate analyses assessing associations involving age, sex, income quintile, area of residence, separation year, and interaction between area and year, quintile and year, and the three-way quintile-area-year interaction, with hospitalizations count, utilized generalized estimating equations (SAS PROC GENMOD with GEE option). Generalized estimating equations (GEE) are useful for analyzing longitudinal data with binary or count outcomes [13,49,50]. Full models of association with both two-way and three-way interactions were run initially, and non-significant effects were removed in successive runs. Clusters were defined by age category, sex, area of residence and income quintile, and assessed over years. Due to the strongly age-dependent nature of the disease, and consequent very low or null counts in categories with young age groups, only ages 40+ were included in GEE analyses.

For all analyses, statistical test results with probability less than 5.0% were deemed significant.

Results

Trends in separations rates

Figures 1 through 5 illustrate annual age-sex adjusted separations rates for all cancers, and lung, colorectal, breast, and prostate cancers, respectively, from the 1991–1998 British Columbia 10% sample. Data points with 95% confidence intervals were calculated from BCLHD resource data sets as described above. Lines represent best-fit regression lines assessed by joinpoint regression. Tables 2 and 3 detail slopes and estimated annual percent change (EAPC) respectively for each regression line, for all, first and other separations, for all and specific cancers.

All separations age-sex adjusted rates for all cancers and lung, breast, and prostate cancers declined significantly from 1991 through 1998. In contrast, colorectal cancer all separations rates were stationary, that is, neither slope nor EAPC were significantly different from zero. Time trends for all cancers and each specific cancer were described adequately by a single regression line with no joinpoint (discontinuity).

First separations yield slightly less consistent results. Both all cancer and lung cancer annual rates are best represented by two line segments, with joinpoints at 1995.4 and 1995.6 respectively. Slopes are significantly negative in the first segment; they are positive and zero in the second segment for all and lung cancer, respectively. Interestingly, EAPC 95% confidence intervals for all four segments span zero; that is, regardless of respective slopes, there is no significant annual change in rates for all and lung cancer first separations rates. Colorectal, breast, and prostate cancers each display a single regression line for first separations rates. Colorectal and breast cancer slopes and EAPCs are not significantly different from zero. Prostate cancer first separations rates significantly declined through the study period, and the EAPC is significantly negative.

Other separations represent additional separations beyond the initial hospitalization for each individual, and are the difference between first and all separations total counts. All cancers' other separations are discontinuous at one joinpoint, at 1995.8 (Table 2). The slope of the first line segment is not significantly different from zero; the second segment slope is significantly negative. Other separations for each specific cancer exhibit significantly negative slopes with a single line sufficient to represent each trend over the study period. All cancers' EAPC 95% confidence interval for the first segment spans zero. Other separations EAPC for the second segment for all cancers is significantly negative, as are EAPCs for lung, colorectal, breast and prostate cancers.

Potential determinants of hospitalization

Table 4 presents results from multivariate analyses for association of area of residence, income quintile and separation year with all, first and other cancer separations. The outcome variable is the cancer separations count (off-

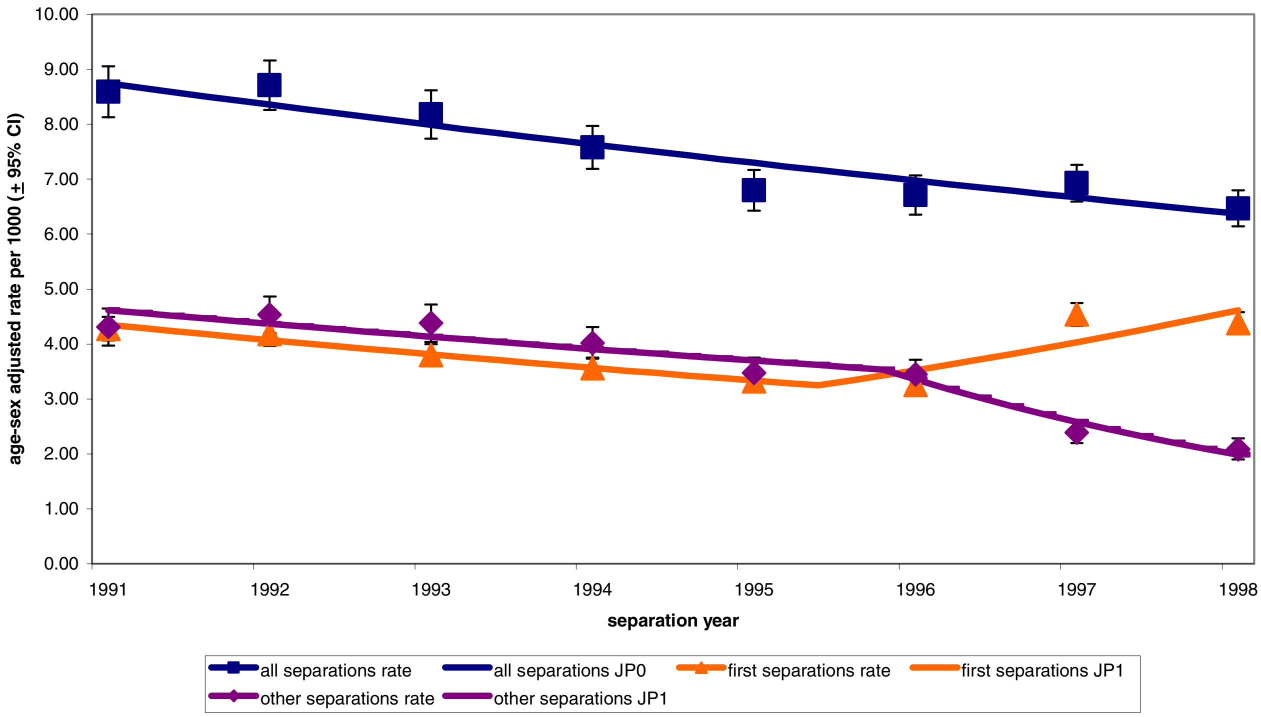

Figure 1
All cancers (ICD-9 140–208, excluding 173) age-sex standardized rates per thousand population (± 95% confidence interval) for first, other and all hospital separations, provincial 10% sample, 1991–1998. Rates were standardized to the 1991 BC population. Data points are age-sex standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

set by population denominator) amongst categories of age, sex, area, income quintile and separation year. Given known relationships between cancer development and age and sex, these variables are considered *a priori* (and, as well, are *a posteriori*) significant. Full models of association with both two-way (area-year and quintile-year) and three-way (area-quintile-year) interactions were run initially, and non-significant effects were removed in successive runs. In all cases only the main effects were required to explain the data. That is, there were no significant interactions of area of residence with year, income quintile with year, or area, quintile and year interaction.

Results for all cancers in aggregate indicate that area of residence is significantly associated with hospitalizations for all and other but not first separations; income quintile is significant for none, and separation year matters for all, first and other separations. Similarly through the rest of the table, area is significant in all and other separations for lung and prostate cancer, and for colorectal cancer other separations, but not for any specific cancer first separations. Income matters only for breast cancer all separations. Separation year is a significant factor for lung first and other separations, and for prostate cancer all and other separations. As well, separation year is significantly associated with first colorectal cancer separations and other breast cancer separations.

Discussion and conclusions

This paper assessed trends in utilization patterns for cancer hospitalizations, and determinants of those trends, during a decade of health care reform. Using data drawn from a 10% sample of British Columbia health service users over the years 1991–1998, we asked two questions. First, do hospitalization rates display discontinuities consistent with the timing and/or intent of health care reform? Second, are there significant associations involving area of residence, income quintile or hospitalization year, or interactions of area, quintile and year, with hospitalizations?

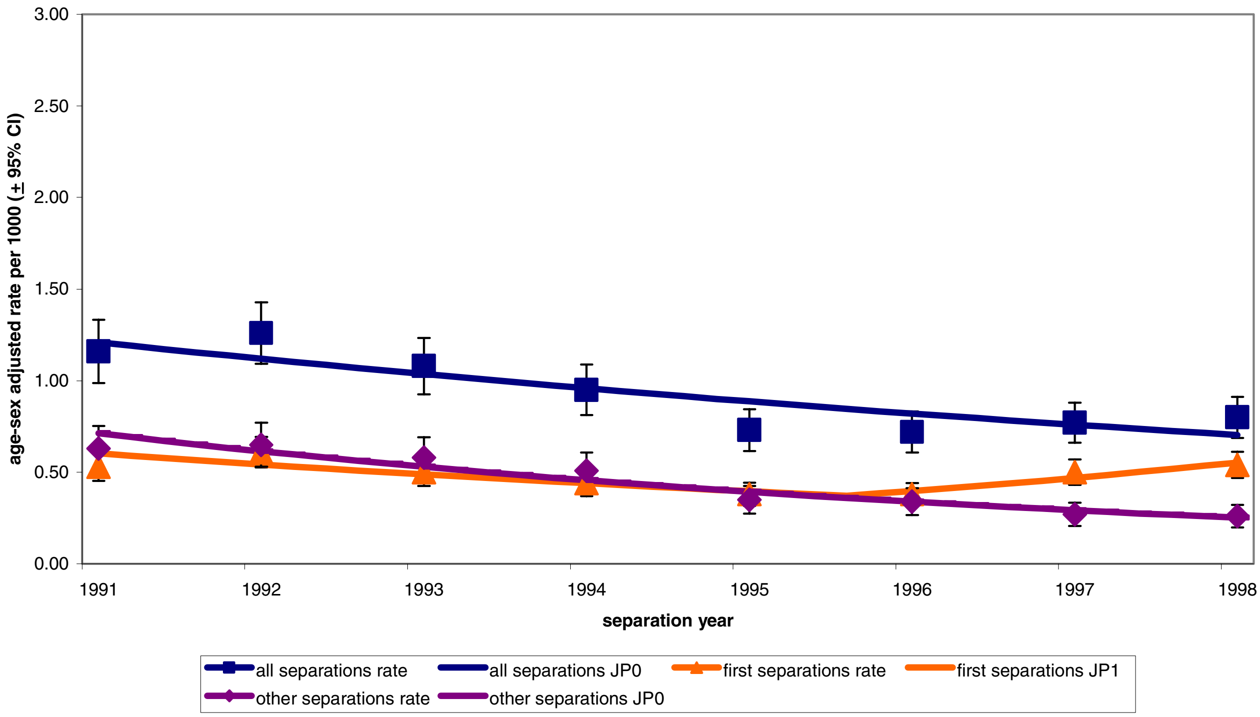

Figure 2
Lung cancer (ICD-9 162) age-sex standardized rates per thousand population (± 95% confidence interval) for first, other and all hospital separations, provincial 10% sample, 1991–1998. Rates were standardized to the 1991 BC population. Data points are age-sex standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

Trends in hospitalization rates
Findings indicated that all separations rates did not display any discontinuity consistent with a system responding to abrupt policy change. Instead, steady reductions in cancer separations rates were observed over the decade, in agreement with previous studies of general hospital utilization rates following health system reforms. Specific cancer hospitalizations, with the exception of colorectal cancer, which is stationary, also displayed consistent decline over time. Hence, health care reforms through the 1990s did not precipitate sudden alterations in general cancer hospitalization trends.

First separations were examined as proxy incidence, on the proposition that an individual with cancer will be treated at a hospital at least once during the course of the disease. Incident cases indicate demand for services over time. As incidence, first separations are unlikely to be affected by health policy, since policy changes observed do not occur within the time frame necessary to influence cancer disease development, a process that takes many decades. Policy changes may influence first separations where such changes allow increased access to extant or new screening procedures. In addition, first separations may be influenced by changes in technology and treatment patterns, for example where a change in technology allows early detection, as was the case for prostate cancer through the 1980s and 1990s.

Unlike all separations, all cancers first separations rates display a discontinuity, and consequently two line segments; the joinpoint occurs just after the start of 1995. Prior to the joinpoint, the slope of the line is significantly negative; following, the slope is significantly positive. Lung cancer first separations also contain a discontinuity during 1995. Again, the first segment displays a significantly negative slope; post-1995 the slope is not significantly different from zero. In contrast, colorectal, breast, and prostate cancer first separations rates are all adequately described by a single line. Of the three, only the prostate cancer first separations slope is significantly (negatively) different from zero.

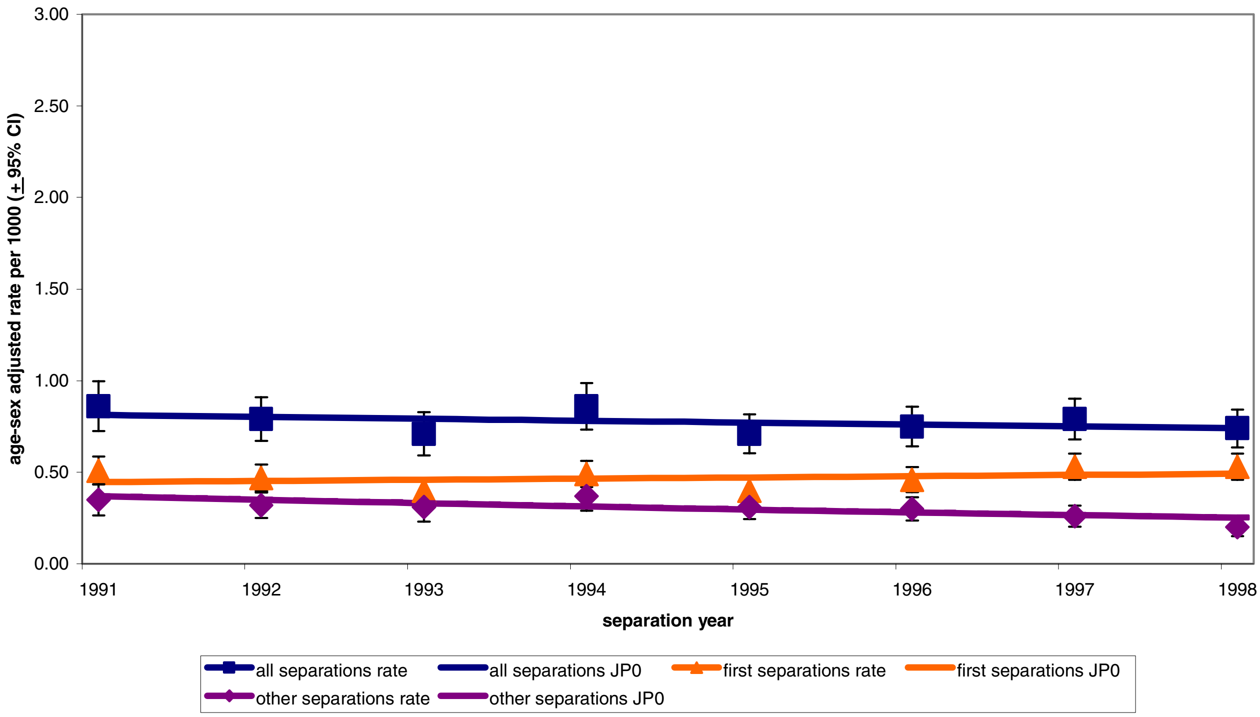

Figure 3
Colorectal cancer (ICD-9 153–154) age-sex standardized rates per thousand population (± 95% confidence interval) for first, other and all hospital separations, provincial 10% sample, 1991–1998. Rates were standardized to the 1991 BC population. Data points are age-sex standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

We use other separations to examine hospitalization trends without reference to first separations. All cancers' other separations exhibit a joinpoint slightly following that of first separations, and mirror the first separations pattern. That is, while the second segment of first separations has positive slope, other separations' second segment has negative slope. The consistently declining all separations pattern, then, is a result of other separations' rate decrease despite first separations' rate increase.

In contrast, other separations for each specific cancer require only one regression line to describe the trend over time, and each exhibits a significantly negative slope. As noted above, first separations should reflect demand and not changes in policy or treatment. By extension, all and particularly other separations should reflect these latter changes. Only all cancers other separations display a discontinuity, in 1995, two years following the initial implementation of administrative restructuring in 1993.

If hospitalizations for cancer follow a characteristic pattern, we would expect first and additional, or other, separations rates to vary in parallel over time. Furthermore, this should hold for all cancers (an aggregate of many different treatment patterns), and with reference to specific cancers. If the trends do not vary in parallel, then there will be intervening factors that explain the disparities. From Table 2, directions of slopes agree only for prostate cancer, where both first and other separations decline over the study period. However, for all cancers, as well as for lung, colorectal and breast cancer, first and other separations yield disparate results. For example, breast cancer first separations slope is not different from zero, while that for breast cancer other separations is significantly negative. At least for all cancers, lung, colorectal and breast cancer, it would appear that some event or events during 1991 through 1998, other than first separations (incidence), affected other separations rates.

There are several sources of explanation for changes in these rates. In addition to health policy, they may include

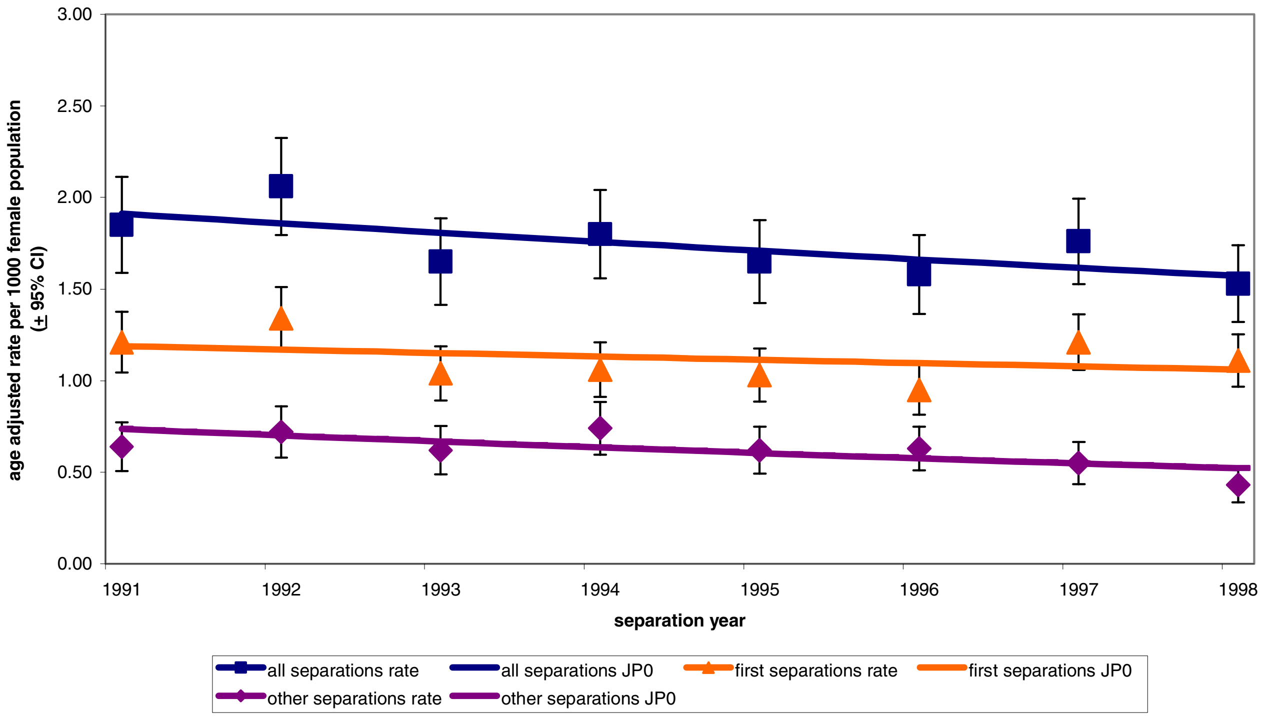

Figure 4
Breast cancer (ICD-9 174) age standardized rates per thousand female population (± 95% confidence interval) for first, other and all hospital separations, provincial 10% sample, 1991–1998. Rates were standardized to the 1991 BC female population. Data points are age-standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

changes in incidence, modifications in detection and treatment, or alterations in treatment location (*e.g.* a shift from hospital to another community location). We cannot deal directly with effects of modifications in detection or treatment, including treatment location, using these data. However, we can discuss the likelihood of changes in incidence affecting overall decline in hospital utilization over the study period.

Declines in all and other separations rates may be a result of reduced demand, that is, either reduced absolute frequencies or standardized rates of incident cancers. However, British Columbia Cancer Agency figures [51] indicate an increasing absolute count of incident cases from 1970 through 2000. Similarly, previous BCLHD analysis (paper in manuscript) showed increases in frequency of absolute counts of first separations in British Columbia over the 1990s. In addition, National Cancer Institute of Canada statistics [43] also note increasing absolute numbers of cancer cases as the Canadian population ages. Thus, decreased absolute numbers of disease cases cannot be the source of decreasing hospitalizations.

What about age-sex adjusted incidence rates? If these rates are decreasing, it would suggest that age-standardized demand for hospitalization will decrease, without influence from health care reform or other developments. Canadian cancer statistics [43] indicate, with some exceptions, that incidence rates for cancer in Canada were stable or declined during the 1990s. For example, all cancers age-standardized incidence rates for men ranged between 4.46 and 4.94 per thousand from 1991–1998; for women rates were between 3.35–3.45 per thousand. Calculations for average annual percentage change (AAPC) in age-standardized incidence rates, among the specific cancers examined here for 1991–1998, a period precisely contiguous with the present study, indicate the following. First, incidence AAPC in all cancers among men was significantly negative (-1.2%), whereas for women there was no significant change (0.1%). For lung cancer, both men and women experienced significant change, but in opposite

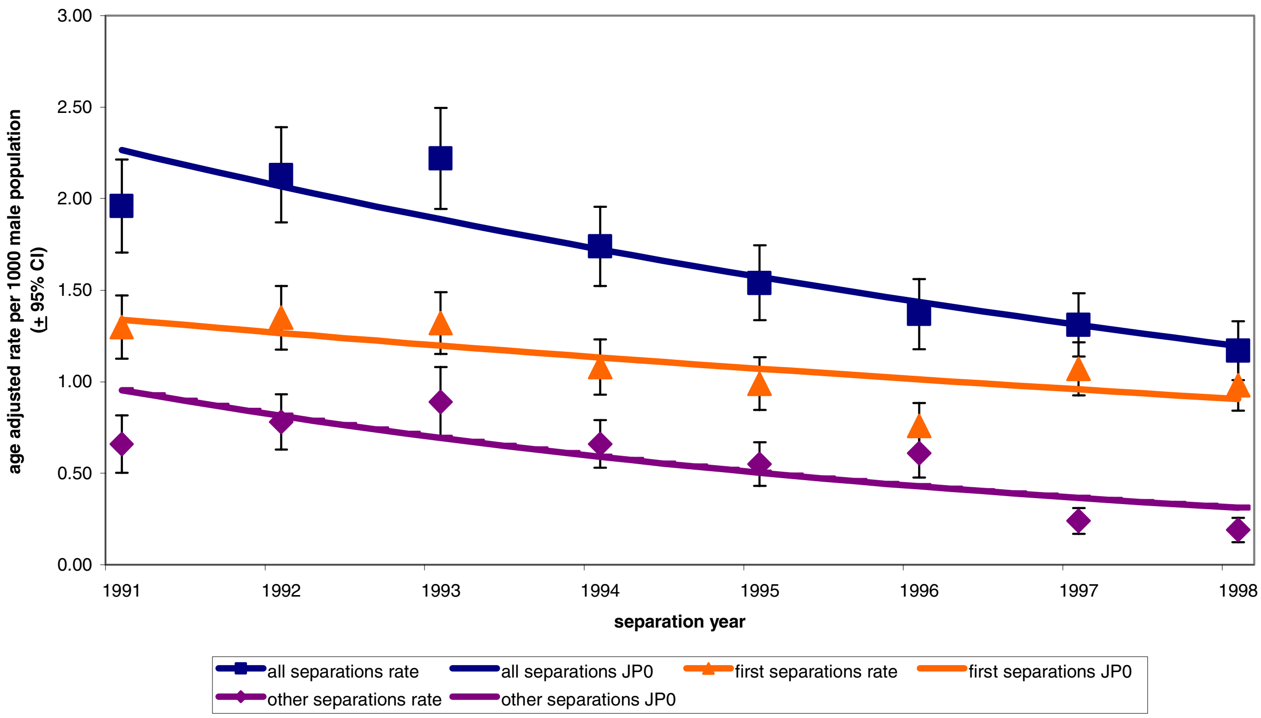

Figure 5
Prostate cancer (ICD-9 185) age standardized rates per thousand male population (± 95% confidence interval) for first, other and all hospital separations, provincial 10% sample, 1991–1998. Rates were standardized to the 1991 BC male population. Data points are age-standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

Table 2: All and specific cancers, all, first and other separations' slope from joinpoint regression.

cancer	separation	trend	slope	SE	Z	Prob > |Z|
all	all	JP0	-0.05	0.01	-6.96	0.00
	first	JP1 @ 1995.4 (1992.6 – 1996.8)				
		segment 1	-0.07	0.03	-2.21	0.03
		segment 2	0.14	0.06	2.12	0.03
	other	JP1 @ 1995.8 (1992.2 – 1996.8)				
		segment 1	-0.06	0.03	-2.05	0.11
		segment 2	-0.26	0.07	-4.01	0.02
lung	all	JP0	-0.08	0.02	-4.27	0.00
	first	JP1 @ 1995.6 (1993.4 – 1996.8)				
		segment 1	-0.10	0.04	-2.72	0.01
		segment 2	0.17	0.09	1.95	0.05
	other	JP0	-0.15	0.02	-9.40	0.00
colorectal	all	JP0	-0.01	0.01	-1.16	0.25
	first	JP0	0.01	0.02	0.75	0.45
	other	JP0	-0.05	0.02	-2.80	0.03
breast	all	JP0	-0.03	0.01	-2.46	0.01
	first	JP0	-0.02	0.02	-1.00	0.32
	other	JP0	-0.05	0.02	-2.47	0.05
prostate	all	JP0	-0.09	0.01	-6.21	0.00
	first	JP0	-0.06	0.02	-2.72	0.01
	other	JP0	-0.16	0.05	-2.99	0.02

Table 3: All and specific cancers, all, first and other separations' estimated annual percent change (EAPC) with 95% confidence limits (CL) from joinpoint regression.

All separations				
cancer	trend	EAPC	low 95% CL	high 95% CL
all	JP0	-4.413	-5.917	-2.885
lung	JP0	-7.473	-11.504	-3.258
colorectal	JP0	-1.325	-4.071	1.500
breast	JP0	-2.765	-5.442	-0.013
prostate	JP0	-8.715	-11.938	-5.374
First separations				
cancer	trend	EAPC	low 95% CL	high 95% CL
all	JP1 @ 1995.4 (1992.6 – 1996.8)			
	segment 1	-6.448	-13.951	1.708
	segment 2	14.496	-4.094	36.691
lung	JP1 @ 1995.6 (1993.4 – 1996.8)			
	segment 1	-9.967	-19.110	0.209
	segment 2	18.068	-6.845	49.644
colorectal	JP0	1.398	-3.072	6.074
breast	JP0	-1.616	-5.468	2.392
prostate	JP0	-5.428	-10.057	-0.561
Other separations				
cancer	trend	EAPC	low 95% CL	high 95% CL
all	JP1 @ 1995.8 (1992.2 – 1996.8)			
	segment 1	-5.394	-12.224	1.968
	segment 2	-23.090	-35.875	-7.756
lung	JP0	-13.791	-17.058	-10.395
colorectal	JP0	-5.342	-9.779	-0.687
breast	JP0	-4.785	-9.295	-0.051
prostate	JP0	-14.794	-25.261	-2.862

directions (for men, -2.3%, and for women, +1.6%). Colorectal cancer exhibited a significant downward shift for men (-0.6%) and no significant change for women (-0.7%). AAPCs for both breast cancer and prostate cancer were not different from zero (0.2% and -1.5% respectively).

These AAPCs in incidence rates, used as measures of changing annual demand for services, can be compared to the estimated annual percent change (EAPC) in hospitalizations calculated here and presented in Table 3. All separations EAPCs for all cancers and each specific cancer, other than colorectal cancer, were significantly and consistently negative, whereas EAPCs for first separations were not significantly different from zero for all or any specific cancer except prostate. EAPCs for other separations for all categories, except all cancers first line segment, were significantly negative. Again, separations rates appear to be influenced by factors in addition to simple cancer incidence. These factors may include alterations in policy, treatment patterns and locations.

Finally, rates may vary over time as a result of changes that shift procedures from in-patient to out-patient admission (or *vice versa*). However, data analyzed here include both in- and out-patient separations, suggesting such changes would not be reflected in this analysis.

Potential determinants of hospitalization

Table 4 presents results from the multivariate analyses of area of residence, income quintile and separation year, with all, first and other cancer hospitalizations counts (offset by population). Consider the first column of Table 4, describing results for all cancers in aggregate. How can these be interpreted?

For all cancer hospitalizations, income quintile does not figure as an important player, whether first, other or all hospitalizations are considered. Area, on the other hand, while non-significant for first separation, matters when either all or other hospitalizations are assessed. Detailed examination of the GENMOD-GEE results indicates that the more rural areas (CHSSs) experience more events

Table 4: Multivariate results for association of age, sex, area, income quintile and separation year with cancer count (offset by population count), for first, other and all separations by all and specific cancers (SAS PROC GENMOD-GEE). Results shown are chi-square, associated degrees of freedom (DF) and p-values of score statistics for type 3 GEE analysis.

All separations

		all cancers		lung		colorectal		breast		prostate	
	DF	Chi-square	p	Chi-square	p	Chi-square	p	Chi-square	p	Chi-square	p
age	4	55.16	<0.0001	50.00	<0.0001	51.95	<0.0001	18.92	0.0008	30.85	<0.0001
sex	1	18.79	<0.0001	24.58	<0.0001	22.70	<0.0001	-	-	-	-
area	1	7.03	0.0080	6.06	0.0138	3.32	0.0685	0.42	0.5174	4.33	0.0375
quint	4	1.40	0.8446	6.32	0.1767	7.59	0.1079	10.39	0.0344	8.82	0.0657
syear	7	18.32	0.0106	13.75	0.0558	7.71	0.3589	7.08	0.4209	15.04	0.0355

First separations

		all cancers		lung		colorectal		breast		prostate	
	DF	Chi-square	p	Chi-square	p	Chi-square	p	Chi-square	p	Chi-square	p
age	4	52.09	<0.0001	51.51	<0.0001	52.88	<0.0001	20.33	0.0004	29.65	<0.0001
sex	1	16.60	<0.0001	22.04	<0.0001	22.19	<0.0001	-	-	-	-
area	1	1.74	0.1869	2.84	0.0917	0.81	0.3685	1.18	0.2774	1.92	0.1664
quint	4	1.88	0.7584	7.37	0.1175	8.03	0.0903	8.92	0.0632	7.90	0.0952
syear	7	44.79	<0.0001	21.69	0.0029	20.84	0.0040	13.61	0.0585	13.66	0.0575

Other separations

		all cancers		lung		colorectal		breast		prostate	
	DF	Chi-square	p	Chi-square	p	Chi-square	p	Chi-square	p	Chi-square	p
age	4	50.55	<0.0001	49.87	<0.0001	41.14	<0.0001	20.37	0.0004	31.85	<0.0001
sex	1	18.51	<0.0001	24.27	<0.0001	15.69	<0.0001	-	-	-	-
area	1	11.95	0.0005	6.80	0.0091	5.59	0.0180	3.10	0.0781	5.73	0.0166
quint	4	0.85	0.9318	5.10	0.2774	4.86	0.3023	8.71	0.0687	8.08	0.0885
syear	7	46.56	<0.0001	23.60	0.0013	10.68	0.1530	16.30	0.0225	21.01	0.0038

(hospitalizations) than more urban areas (RHBs) for both all and other separations. This result is in agreement with prior analysis (data not shown), indicating elevated all separations age-sex adjusted rates in Upper Island – Central Coast, a CHSS, in contrast to rates from the province and two RHBs. Separation year is significantly associated with each of first, other and all separations. Detailed parameter estimates indicate all and other separations exhibit elevated events earlier in the study period. These results are consistent with observed trends in hospital utilization, indicating declines in recent years. First separations parameter estimates, in contrast, indicate fewer separations earlier in the time period. In other words, all and other separations decrease over time despite rising first separations counts.

Which variables associate significantly with specific cancers? With regard to area of residence, the more rural CHSS populations experience elevated hospitalization levels over urban RHB populations for lung and prostate cancers, and lung, colorectal and prostate cancers, for all and other separations respectively. There is no association of area with first separations for any specific cancer.

Income quintile is significant only for all separations for breast cancer. Here, pairwise contrast of quintiles shows higher incomes (Q3 – Q5) form a consistent cluster as do lower incomes (Q1 and Q2). However, and curiously, Q1 is not significantly different from Q5. Where significant, parameter estimates indicate fewer hospitalizations amongst lower income quintiles. We calculated rates for income clusters defined as Q1 – Q2 *vs*. Q3 – Q5. Figures 6 through 8 depict age adjusted breast cancer separations rates for all, first and other separations respectively, for these clusters. Rates were calculated relative to at-risk groups, that is, rates for cluster 1 (Q1 and Q2) were calculated with the denominator as age structured population by income cluster 1. All rates were standardized to the 1991 BC female population. Income clusters all exhibit zero slope. Therefore, to the extent that there are differences across income, as is the case for all separations, these differences were maintained over the decade.

Separation year matters for all separations in prostate cancer only; lung and colorectal cancer first separations; and lung, breast and prostate cancer other separations. For prostate cancer all and other separations, parameter esti-

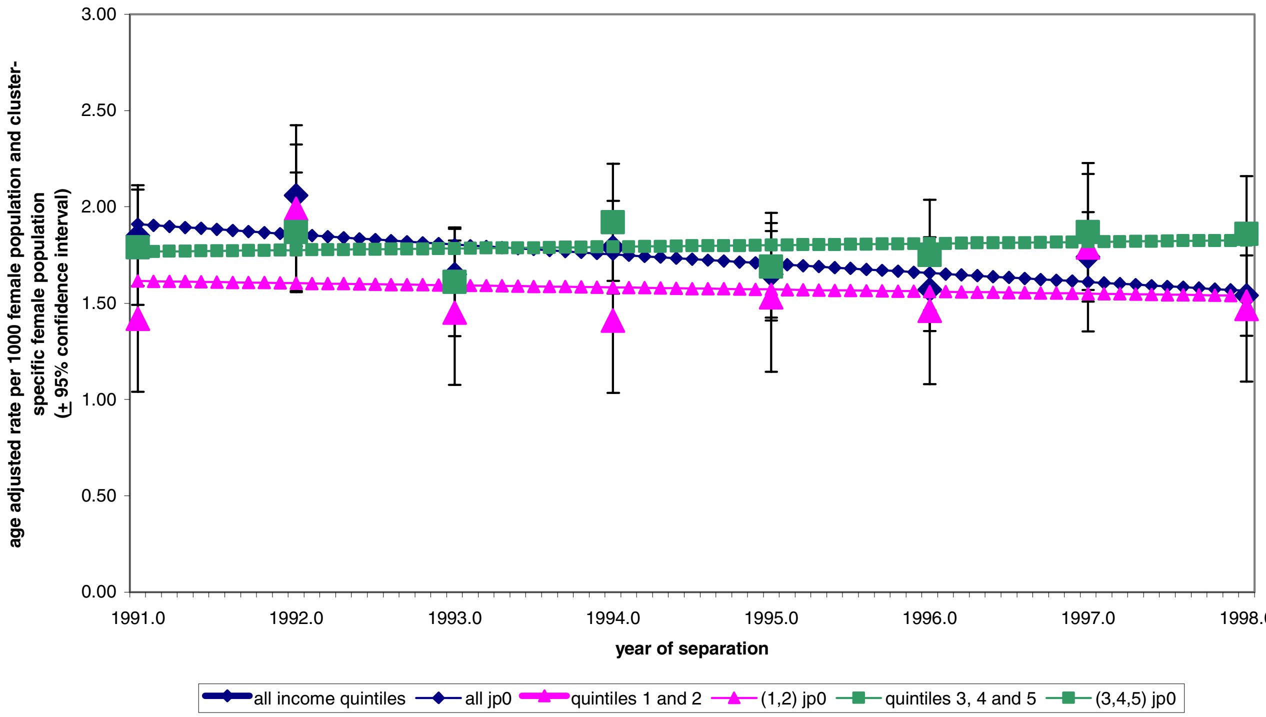

Figure 6
Breast cancer all separations, 1991–1998, by income cluster; 'all quintiles' is per 1000 BC female population, quintile clusters are by cluster-specific female population structure. Rates were standardized to the 1991 BC female population. Data points are age-standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

mates tend to be larger in earlier years. The direction of this association is to be expected since incident prostate cancer cases fell from historic highs in the late 1980s and early 1990s, due to increased detection of cancer following TURP (trans-urethral resection of the prostate) and early detection due to prostate specific antigen (PSA) screening tests [43]. Lung and breast cancer other separations' parameter estimates, where significant, are also greater in earlier years of the study period. However, this pattern is reversed for first lung and colorectal cancer separations. That is, and again where significant, parameter estimates are lower in earlier relative to later years. This trend reflects increasing first separation absolute counts.

Finally, are there any interactions between area of residence, income quintile and separation year? We are interested in whether there are differences in association between areas of residence or income quintiles and hospitalization rates over time that might indicate changing equity of access to care. However, our findings indicate no significant associations for either area of residence or income quintile with first separations in aggregate or specific cancers. In addition, no significant effects were observed for area-year, income-year, or area-income-year interactions for any cancer(s) or separations category. Consequently, we infer there has been no significant change over the study period in ability to obtain access to hospital cancer care relative to area of residence or income level in British Columbia.

Conclusions
Did health care reform unequivocally affect aggregate and specific cancer hospitalizations during the study period, from 1991 through 1998? The answer would appear to be no. Our findings indicate no consistent abrupt changes with respect to all separations that can be associated temporally with health policy reform. Insofar as reforms were designed in response to existing trends, which dictated reductions in hospitalizations, then they acted in concert with those trends. Reforms may have permitted all and other hospitalizations to decline despite relatively constant first separations rates, by creating or buttressing community resources that obviate hospitalization during

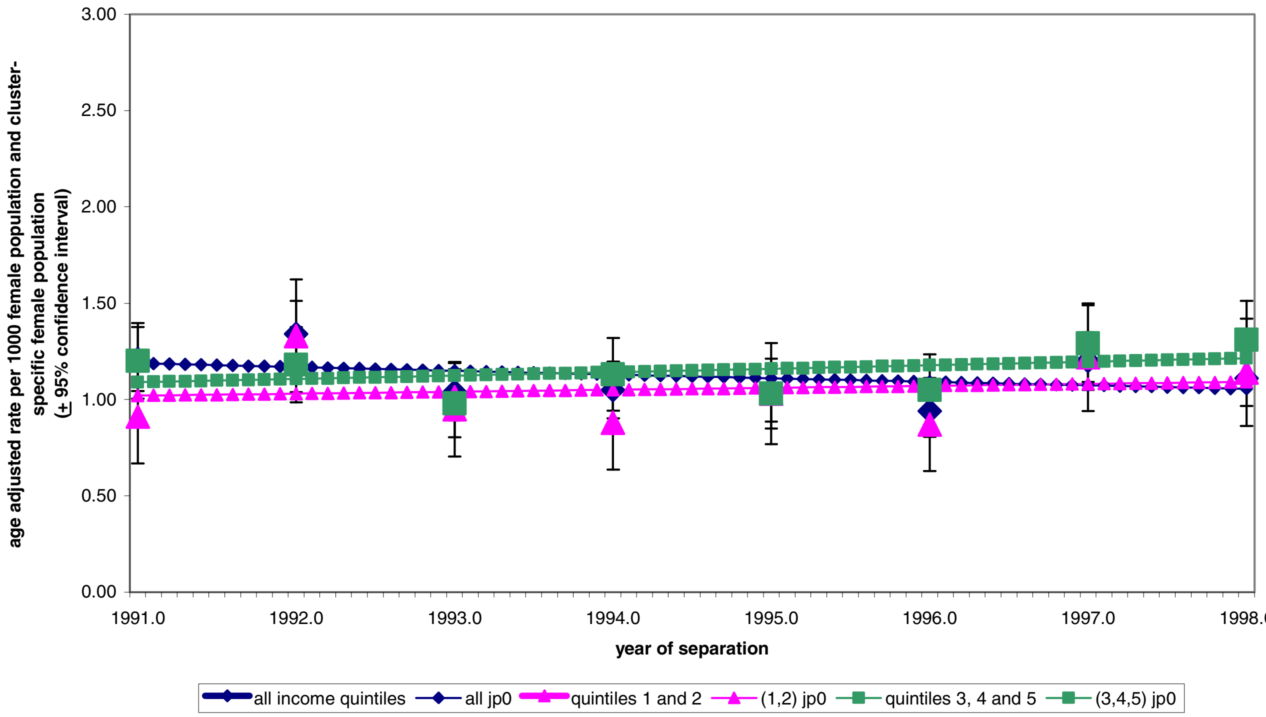

Figure 7
Breast cancer first separations, 1991–1998, by income cluster; 'all quintiles' is per 1000 BC female population, quintile clusters are by cluster-specific female population structure. Rates were standardized to the 1991 BC female population. Data points are age-standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

cancer treatment. Shifting locations for treatment and recovery may influence steady declines in hospitalizations, particularly where health policy directs provision of community care for those with chronic diseases. Direct evidence for this possibility is lacking within data presented here; this will be the subject of future analyses.

Did health care reform alter equity of access to hospital care in different region and income groups? First separation, considered by itself without reference to incidence, is not significantly associated with area of residence or income quintile, nor is there any observed interaction for first, all or other separations between area and year, income quintile and year, or area, income and year. Insofar as these data are concerned there has been no significant change over the study period in access to care across groups, and these findings concur with previous reports indicating no change consequent on health care reform.

If first separation is indeed a valid marker for incidence, then based on these data British Columbia residents do not appear to be developing cancer differentially by socioeconomic status or region of residence. However, we also note that an association between SES and cancer incidence has been observed in the Canadian context. For example, Gorey et al. [19], using Toronto data from the Ontario Cancer Registry, observed significantly greater lung and colon cancer incidence among areas with lower SES, and greater breast and prostate cancer incidence among areas with higher SES. Either BCLHD first separations are not a reasonable proxy for incidence, or the BCLHD sample analysed here failed to detect incidence differentials among income groups, or the Toronto differentials do not hold in British Columbia. Until these alternatives can be differentiated, we are reluctant to conclude that equity in access to care has been achieved or maintained.

This study has several limitations. BCLHD data analysed here were requested originally for a study primarily examining regional variation in general service utilization during health reform. The provincial sample represents 10% of BC residents who used the health care system from

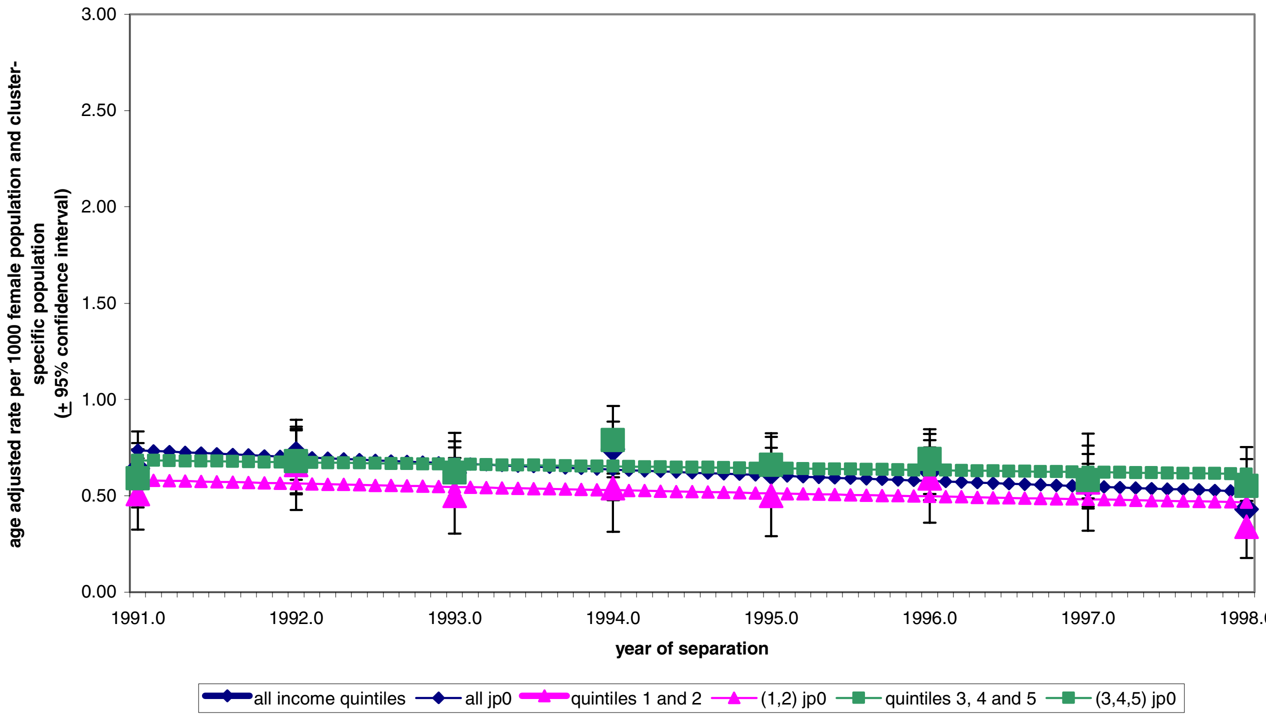

Figure 8
Breast cancer other separations, 1991–1998, by income cluster; 'all quintiles' is per 1000 BC female population, quintile clusters are by cluster-specific female population structure. Rates were standardized to the 1991 BC female population. Data points are age-standardized rates with confidence intervals for observed data; lines indicate best fit joinpoint regression lines.

1990–1991 through 1998–1999. As such, the sample is a longitudinal, nine-year, 10% sample, rather than a single annual 10% sample followed longitudinally, or nine annual 10% cross-sectional samples. Further, the 10% sample with respect to cancer hospitalizations is small for some areas, particularly when subdivided by specific cancer, age, sex, income quintile and separation year. We will be examining a larger BCLHD sample, requested specifically for this purpose, to establish whether results presented here are consistent. Finally with respect to the sample, reforms were planned and variously implemented throughout the 1990s. Data analysed here extend only to 1998. It is possible that analysis beyond 1998 may show altered hospitalization trends.

With respect to first separation acting as a marker for incidence, at the moment the suggestion is a logical conjecture supported indirectly rather than empirically verified. We are proceeding to directly test the relationship. In addition, and as indicated above, the income measures that were used are based on 1996 Census enumeration areas, and therefore the analysis is ecological rather than individual. We note that literature on cancer and SES provides a rationale for using area income measures, given evidence that community SES is significantly associated with stage-at-diagnosis and survival (for example, in Canada [24], but see [19]; in the United States, [52-54]). Finally, it is beyond the scope of the present analysis to evaluate effects of changes in cancer treatment on hospital and community care utilization. Future analyses, with data specifically requested for this purpose, will examine treatment patterns and cancer service utilization, equity and health outcomes among the British Columbia population.

In 2001, following a change in government, British Columbia again restructured its health care system [55]. Studies examining health system changes during the 1990s will be important not just to evaluate effects of those reforms on utilization and population health status, but also to provide a baseline against which to evaluate this most recent round of health system reorganization.

List Of Abbreviations

ICD-9 International Classification of Diseases, 9th revision

Competing Interests

MEB none declared.

MJP none declared.

Authors' Contributions

MJP conceived and initiated our studies using the BCLHD resource to investigate health system change, and its effect on equity across SES and area of residence, particularly with respect to older populations. MEB specifically delineated cancer hospitalizations as an area of analysis. Both authors participated in designing the analytical strategy. MEB managed the data, performed the statistical analysis and drafted the manuscript. Both authors edited and approved the final manuscript.

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