Estimation of hospital costs for colorectal cancer care in Nova Scotia

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BACKGROUND: Colorectal cancer (CRC) is the second most common invasive cancer in Canada. Estimates of the costs of care allow estimation of the cost effectiveness of screening for premalignant and early disease.
OBJECTIVE: To estimate, from administrative data, the hospital costs incurred by a population-based cohort of CRC cases over three years from diagnosis.
DESIGN: All Nova Scotia residents with CRC who were diagnosed in 1990 were identified from the Nova Scotia Cancer Registry. These cases were linked to the administrative files of the Nova Scotia Department of Health, which contain information on diagnosis, procedures and length of stay for all admissions and day surgery visits to Nova Scotia hospitals.
MEASUREMENTS: The lengths of stay and hospital-specific per diem rates were used as the measures of resource use. The costs were analyzed in terms of the extent of spread at diagnosis; the time period after diagnosis; the time period before death; and, for typical cases, the age and presence of comorbidity identified during the initial surgical admission.
RESULTS: The estimated three-year hospital cost for the complete cohort of 593 cases was $9.8 million. This cost was significantly less for cases with local spread, highest in the six months around, and after diagnosis and in the final six months of life, and highest in the typical cases (patients who were older and had significant comorbid conditions).
CONCLUSIONS: Hospital-specific per diem rates and lengths of stay are an approximate measure of hospital resource use.

Key Words: *Colorectal cancer; Hospital costs*

Estimation des coûts du traitement hospitalier du cancer colorectal

HISTORIQUE : En terme de fréquence, le cancer colorectal se classe au deuxième rang parmi les cancers invasifs au Canada. L'estimation des coûts associés au traitement donne un aperçu du rapport coût:bénéfice associé au dépistage de la maladie au stade précoce ou prénéoplasique.
OBJECTIF : Estimer, à partir des données administratives, les coûts hospitaliers encourus par une cohorte de cas de cancers colorectaux basée dans la population échelonnés sur les trois ans suivant le diagnostic.
MODÈLE : Tous les Néo-Écossais atteints d'un cancer colorectal qui ont reçu leur diagnostic en 1990 ont été retracés à partir du registre des cancers de la Nouvelle-Écosse. Ces cas ont été reliés aux dossiers administratifs du ministère de la santé de la Nouvelle-Écosse, qui renferme des données sur les diagnostics, les interventions et la durée des séjours de tous les patients hospitalisés ou admis pour une chirurgie d'un jour dans les hôpitaux de la province.
PARAMÈTRES : Les durées de séjour et les taux *per diem* spécifiques aux hôpitaux ont été utilisés comme mesures d'utilisation des ressources. Les coûts ont été analysés sur les plans de l'étendue de la maladie au moment du diagnostic; la période suivant le diagnostic; la période précédant le décès et dans les cas typiques, l'âge et la présence de comorbidités identifiées durant l'admission chirurgicale initiale.
RÉSULTATS : L'estimation des coûts hospitaliers échelonnés sur trois ans pour la cohorte complète de 593 cas a été de 9,8 millions de dollars. Ce coût s'est révélé nettement moindre pour les cas où la maladie était localisée, plus élevé environ six mois et plus après le diagnostic et au cours des six derniers mois de vie, et plus élevé dans les cas typiques (les patients plus âgés et présentant des comorbidités importantes).
CONCLUSIONS : Les taux *per diem* spécifiques aux hôpitaux et la durée des hospitalisations permettent de mesurer approximativement l'utilisation des ressources hospitalières

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Cancer of the colon and rectum is the second most common cancer in Nova Scotia and North America (1,2). Care of this group of patients consumes a significant portion of available health care resources (3), and is provided in hospitals and clinics by physicians and other health professionals. A study of the elements involved in this care and the costs of these elements allows estimation of the total costs and the effects of changing aspects of the care. Because this cancer is amenable to screening (4,5), the impact of a population screening program could be estimated in terms of costs of care that would not be required if the disease were prevented. This information is one of the data requirements for a cost effectiveness study of a colorectal cancer (CRC) screening program. Although studies in the United States using Medicare (6) data have been performed to determine whether such data can determine the incidence and the initial treatment of cancers, no comparable Canadian data are available.

This study was undertaken to estimate the hospital costs incurred by patients with CRC in the three years after diagnosis, and to evaluate the time course of these costs and the relationship between the extent of spread at time of diagnosis and the costs incurred.

PATIENTS AND METHODS

All of the residents diagnosed with CRC in 1990 in Nova Scotia were identified in the Nova Scotia Cancer Registry database by selecting patients of groups C18, C19 and C20 of the International Classification of Diseases (Oncology) (7). The date of diagnosis, the extent of the spread of disease at the time of diagnosis and the date of death, if applicable, were included in these records. The date of diagnosis was the date that the diagnostic, pathological specimen was obtained or the date that the clinical diagnosis was made if there was no pathological confirmation. The extent of spread included in the registry was validated for all cases diagnosed at the Victoria General Hospital (the largest tertiary care hospital in the province) by blinded chart review. Using the Medical Services Insurance (MSI) number for each individual, these records were linked deterministically with Nova Scotia Department of Health admission/separation/day surgery (ASD) data. The MSI numbers were encrypted by a program unknown to the researchers to ensure confidentiality. The ASD data contained a record for each hospital admission and day surgery visit that occurred in the province. From these ASD data, the length of hospital stay, the hospital name, and the International Classification of Diseases diagnosis and procedure codes (8) were selected for analysis.

Per diem costs for each hospital were obtained from the Nova Scotia Department of Health. These costs were based on the quotient of the total budget for the institution and the number of bed days available in a given year. The same per diem cost assigned to a day surgery visit was assigned to an inpatient day. The total hospital cost for a patient during the three years after diagnosis was estimated using the product of the lengths of hospital stay and the hospital-specific per diem costs that occurred during admissions; there were separation dates on or after the date of diagnosis up to three years after the diagnosis. The date of diagnosis was established from the Nova Scotia Cancer Registry, and was the date when the diagnostic specimen was obtained, the date of the diagnostic surgical procedure or, if neither of these dates were available, the date of the report to the cancer registry. The date of death was obtained from the Nova Scotia Department of Vital Statistics via the Canadian Mortality Database. Using the complete ASD data for the total population of the province during the time period of April 1, 1989 to March 31, 1994, mean age- and sex-matched hospital costs were estimated.

To facilitate comparison with other studies, typical surgical cases were identified. Such a case was defined in the ASD data as one in which the primary diagnosis was made after a major surgical procedure occurring during the first admission during the time period. For these typical surgical cases, subsequent admissions were defined as 'surgical' if a major procedure was coded, and 'medical' if no major surgical procedure was performed or if the length of stay was less than five days (unless the separation and death dates coincided). The initial admissions for these cases were classified by 'severity group', based on an age of 70 years or older and presence or absence of comorbid conditions. Comorbidities included pneumonia, diabetes, hypertension, myocardial infarction, heart failure and surgical complications (Table 1).

TABLE 1
Resource use by colorectal cancer patients according to severity group during the initial admission of 384 typical surgical cases in Nova Scotia

Severity group*	Age	Comorbidity and/or complication†	Similar case mix group‡	n	Mean length of stay (days)	Mean cost ($)
All				384	19	7,476
I	<70	None	255§	129	14.5	5,589¶
II	<70	Present	256**	42	18.4	7,825
III	≥70	None	256**	140	20.4	8,056
IV	≥70	Present	257††	73	24.7	9,571¶
II and III			256**	182	19.9	8,005

**As defined by the Nova Scotia Department of Health admission/separation/day surgery data; †One or more of pneumonia, diabetes, hypertension, myocardial infarction or surgical complications; ‡As defined by the Canadian Institute of Health Information; §Case mix group 255: age 18 to 69 years, no comorbidity; ¶These mean costs differ significantly from the mean cost for all cases at the level of P<0.05; **Case mix group 256: age 18 to 69 years with comorbidity, or age 70 years or older without comorbidity; ††Case mix group 257: age 70 years or older with comorbidity*

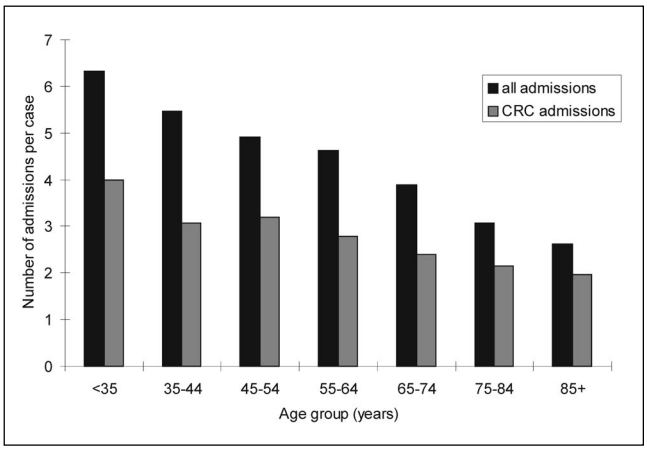

Figure 1) *Number of admissions for colorectal cancer (CRC) patients per case over three years, showing all admissions and those admissions in which CRC was recorded as a diagnosis*

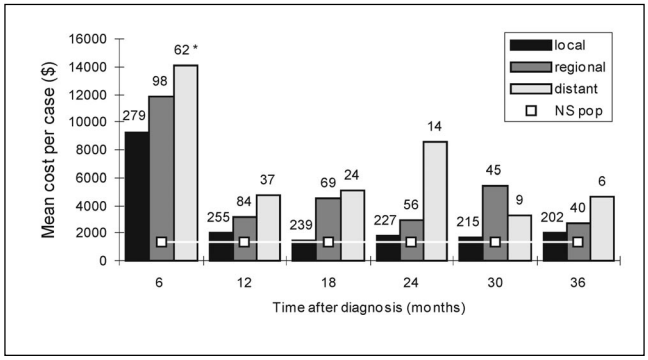

Figure 2) *Costs incurred by surviving patients with colorectal cancer compared with costs incurred by mean age- and sex-matched Nova Scotia (NS) population by time after diagnosis, showing results by the extent of spread of the cancer (local, regional and distant). Numbers represent cases still alive at midpoint of time period for each group*

Differences between means were evaluated using Student's *t* test.

RESULTS

Five hundred ninety-three cases of invasive CRC were identified in the Nova Scotia Cancer Registry as having been diagnosed in 1990. Forty of these cases had no MSI number in the registry – 35 were identified at the time of death clearance and five had insurance other than the provincial medical services insurance plan. Also, 142 of these cases had been diagnosed in the Victoria General Hospital, and the extent of spread was validated by chart review. The remaining 553 cases with MSI numbers were all successfully linked to records in the ASD data. There were 384 typical surgical cases identified. The estimated total hospital cost for these 553 cases was $9.8 million over the three-year period after diagnosis. Eighty per cent of this cost was accounted for by half of the cases.

The 553 cases used 22,460 hospital days during the three years after diagnosis, leading to a mean of 44.1 days per case (median 31, standard deviation 39.4). The 1293 individual inpatient separations varied in length from one to 135 days, with a mean of 16.8 days. When only those admissions for which CRC had been entered into one of the diagnosis fields were considered, the 553 cases had 949 inpatient admissions, with a mean length of stay of 28.3 days. Figure 1 shows the number of hospital admissions per case both for all admissions and for those admissions in which colorectal cancer was recorded as a diagnosis.

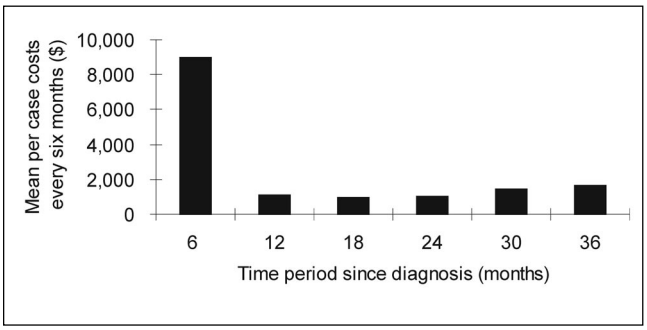

Figure 3) *Per case costs every six months for the 247 patients with invasive cases who survived colorectal cancer 36 months or longer*

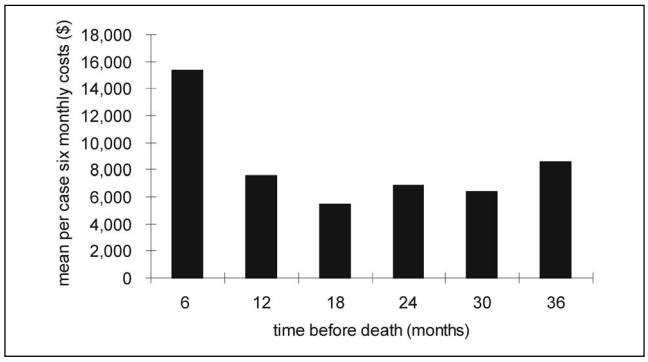

Figure 4) *Costs incurred by 74 patients having colorectal cancer who died 18 to 36 months after diagnosis in six-month time periods before death*

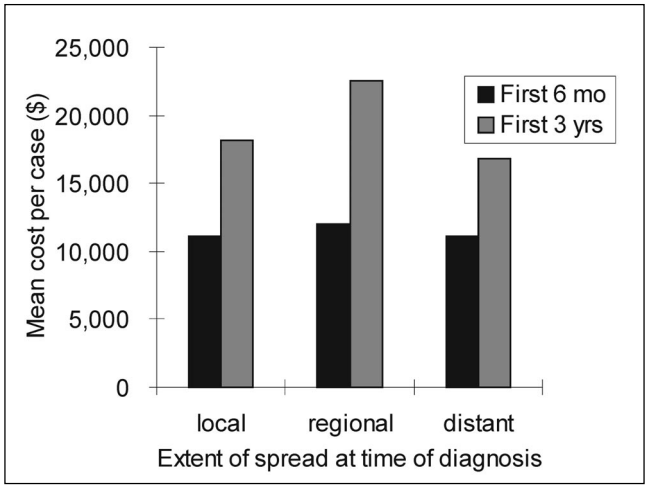

Figure 5) *Mean six-month and three-year hospital costs for differing extents of spread of colorectal cancer at the time of diagnosis. mo Months; yrs Years*

The costs incurred by surviving cases every six months after diagnosis for each extent of spread at the time of diagnosis were compared with estimates for the costs incurred by the Nova Scotia population of the same age and sex distribution. Except for the initial diagnosis and activities during the first six months, the costs for patients with local spread of cancer were only slightly above the mean costs for the population (Figure 2).

Analysis of the costs incurred by nonsurvivors showed that the largest costs occurred during the first six months after diagnosis and during the final six months of life. Figure 3 illustrates the per case costs every six months for the 247 patients who survived 36 months or longer. The majority of costs were incurred in the first six-month period after diagnosis. For the 74 patients who died between 18 and 36 months after diagnosis, considerably more costs were incurred ($15,500 per case) in the final six months before death than in the time periods before that (average $6,900 per case every six months) (Figure 4). The costs incurred in the first six months for each extent of spread at the time of diagnosis were similar, but the total three-year costs were significantly higher for the regional cases (Figure 5).

The 384 typical surgical cases represented 70% of the 553 cases and accounted for over $6.2 million of costs. The mean cost incurred for the initial admission for each of these cases was $7,476 for a mean length of stay of 19 days. Thirty-six per cent of these cases had a least one other surgical admission, and 268 cases had a mean of three subsequent medical admissions each. The use of resources by the four severity groups in the cohort of typical surgical cases is outlined in Table 1. When the four severity groups were compared, there was a definite trend toward higher costs and longer lengths of stay as patients aged and had comorbid conditions or surgical complications.

DISCUSSION

A complete model estimating the direct costs of CRC care would include costs of diagnosis; initial treatment (in or out of hospital) including surgery; chemotherapy and radiotherapy; adjuvant therapy in the form of chemotherapy to prevent recurrence in patients who are thought to be cured by their initial treatment; and palliative treatment both in hospital and in home-care programs through nursing and medical care, further surgery, radiotherapy or chemotherapy for patients not thought to be cured by the initial treatment.

The present study describes the estimation of hospital costs for the initial and continuing care of all cases of adenocarcinoma of the colon and rectum diagnosed in Nova Scotia during 1990. These costs included portions of the phases of diagnosis, initial treatment in hospital, chemotherapy and palliative care. No costs of radiotherapy, physician visits, diagnostic procedures or nonchemotherapy, out-of-hospital drug therapy were included. The costs are described in terms of mean costs incurred per case, time after diagnosis by both survivors and nonsurvivors, and the extent of the spread of the cancer at the time of diagnosis.

Estimated costs incurred in the three years after diagnosis were less when the cancer was diagnosed at an early extent of spread, thus supporting the idea that screening for CRC, leading to diagnosis at an earlier stage, may reduce care costs.

Analysis of the resources used by typical surgical cases suggests that few of the admissions after the first six months are due primarily to CRC. Thus, one might anticipate that the cost for the whole group after three years would not be much different than that incurred by the population at large (Figure 2).

Using separation dates to define the relevant hospital admissions may have led to some bias in the results. At the time of diagnosis, using hospital admissions with separation days at or after the date of diagnosis should have captured all relevant activity at the beginning of the three-year time period. This was confirmed by the finding that there were no hospital admissions with separation dates before the diagnosis date with CRC diagnostic codes. However, it is possible that cases were in hospital on the third anniversary of the diagnosis date and thus would not be captured in the time period selected. This could result in a bias against cases that had prolonged hospital admissions in the latter part of the three-year study period.

The present study's $1300 annual estimate of average population hospital costs was somewhat higher than the estimate made by Roos and Shapiro (9), who suggested an annual cost of $800 for 1988 to 1992 in Manitoba. They arrived at their estimate by dividing the total provincial hospital budget by the total population. Their total budget includes the cost for long term stay facilities and acute care hospitals, while the estimate in this study is based only on the acute care hospitals in which patients with CRC are admitted. The population costs estimated in this Nova Scotia study were also matched to the age-sex distribution of the CRC patients and thus would represent an older group than the entire Manitoba population.

The data used to perform the cost calculations were not complete. The 40 cases without MSI numbers in the Nova Scotia Cancer Registry data were not likely typical of the rest of the cases. They were older and had a much shorter mean survival time than the whole group because 35 of these cases were identified only at the time of death.

The estimated costs for the severity groups showed a trend toward higher costs for the older, more complicated groups, which was expected. These severity groups are defined in an analogous fashion to the Canadian Institute of Health Information case mix groups (CMGs) (Table 1). The major difference is that the most responsible diagnosis in the CMG system is determined after the admission is complete, while the diagnoses in the ASD data were not necessarily defined in that manner from 1990 to 1994. Groupings were not assigned to cases during the time period studied in the Nova Scotia data sets. Severity groups B and C are similar in scope to that of CMG 256, and severity group D is similar to CMG 257. Jacobs et al (10) found the cost for CMG 256 and CMG 257 to be $4,278 and $5,723 at the University of Alberta Hospital during 1992 to 1993, compared with the present study in which costs of $8,005 and $9,571, respec-

tively, were estimated. Jacobs et al (10) assigned costs prospectively using a patient resource consumption profile. Although the present study's higher cost estimates may reflect a cruder costing method, they may also reflect a longer length of stay (19.3 days for severity groups B and C and 24.3 days for severity group D) than the University of Alberta Hospital, which had an average length of stay of 12.9 days for surgical cases. Jacobs et al (10) studied patients who were admitted to 'short stay' home care programs after their acute care surgical admission. Such facilities were largely unavailable in Nova Scotia in 1990 to 1994 and may have allowed shorter lengths of stay for recovery after surgery. They found a per diem cost of $523 for surgical cases and $262 for medical cases. These were similar to the present study's overall per diem cost of $390.

Important limitations of this study include the aggregation of the data on hospital costs using per diem rates. To be more meaningful, it would be necessary to analyze the intensity of care provided during the hospital stay, perhaps by considering the operations performed, the duration of operations, the number of intensive care days, the diagnostic procedures performed, the chemotherapy and radiotherapy provided, etc. However, the similarity between the results using this aggregate per diem method and the more specific patient consumption resource profile method at the University of Alberta Hospital is encouraging. Also, the linkage was dependent on the validity of the MSI numbers. Although the numbers were all internally consistent (they contain a check digit), errors could still have been made during transcription into the records, and thus, records could have been missed in the ASD data. Because of confidentiality restrictions, no attempt was made to use other fields such as age, date of birth, postal code or hospital admission number to improve the linkage.

The major strength of this study is that by linking the population-based Nova Scotia Cancer Registry data with the ASD data, a cohort of cases has been developed that represents 93% of all of the invasive cases of CRC in Nova Scotia. This may allow extrapolation of the results to the entire population. Although the Nova Scotia Cancer Registry is a passive registry, the measures of completeness that are used suggest almost complete data collection (11). These data could be used by decision makers to compare the costs of treating CRC with the costs of treating other common conditions.

Future studies should focus on estimating the costs of other aspects of CRC care. Some of this information would be available from the administrative databases that record physician services and drug use by patients older than 65 years and those on social assistance. About half of the cases of CRC have recorded at least one visit to the ambulatory care centre at the Nova Scotia Cancer Centre. This institution provides all of the radiotherapy in the province, and thus, it would be possible to link to their records to estimate radiotherapy costs. Adjuvant chemotherapy is provided both in that setting and around the province. Therefore, it may be possible to estimate costs of adjuvant chemotherapy provision by linking it with the physician services information. Together with the hospital cost data that have been presented, this further information will allow for the development of a cost effectiveness model for screening programs for CRC.

The three-year hospital costs incurred by all patients diagnosed with CRC in 1990 in Nova Scotia have been estimated by linking epidemiological and survival data obtained from the Nova Scotia Cancer Registry with administrative data collected by the Department of Health and per diem rates for inpatients at Nova Scotia Hospitals. These costs varied with the extent of spread at the time of diagnosis, and with the age and presence or absence of comorbid medical conditions at the time of diagnosis. This per diem method of estimating costs provides an estimate similar to that resulting from more complex methods. Advantages are that cost estimates are based on the whole provincial population and that only relatively simple manipulation of data already collected for other purposes is required.

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