Surgical treatment choices for breast cancer in Newfoundland and Labrador: a retrospective cohort study

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Background: Mastectomy is often chosen by women for treatment of breast cancer, even when breast-conserving surgery (BCS) is an option. Newfoundland and Labrador has a high mastectomy rate. We documented the number of breast cancers over a given period in the province and their related surgical treatments, and explored the impact of several variables on surgical choice.

Methods: A retrospective cohort design linked diagnosis data from the Newfoundland and Labrador tumour registry to surgery data from the Canadian Institute for Health Information Discharge Abstract Database. Data were extracted for all women aged 19 years or more in whom breast cancer was diagnosed in 2009–2014.

Results: A total of 2346 cases of breast cancer with a linked surgical procedure were included. Most operations (1605 [68.4%]) were mastectomy procedures, with the remainder being BCS. Logistic regression analysis revealed that women were 1.82 times (95% confidence interval [CI] 1.64–2.02) more likely to have mastectomy for each unit of stage increase from 0 to IV and 1.15 times (95% CI 1.11–1.21) more likely for each unit of driving time increase.

Conclusion: Tumour stage and driving time to a radiation facility significantly predicted Newfoundland and Labrador women's surgical treatment choices for breast cancer. Notably, mastectomy was the favoured choice across all age groups, tumour stages and geographical regions of the province. We hope that these results will galvanize efforts to better understand local surgical practices and assist in improving the quality of surgical care of women with breast cancer.

Contexte : Les femmes atteintes d'un cancer du sein optent souvent pour la mastectomie, même lorsque la chirurgie mammaire conservatrice (CMC) est possible. Considérant que la province de Terre-Neuve-et-Labrador enregistre des taux de mastectomie élevés, nous y avons recensé durant une période donnée les cas de cancer du sein et les traitements chirurgicaux associés, et avons étudié l'influence de plusieurs variables sur le choix d'intervention.

Méthodes : Suivant un modèle de cohorte rétrospective, nous avons apparié les données diagnostiques du registre des cancers de Terre-Neuve-et-Labrador aux données chirurgicales correspondantes de la Base de données sur les congés des patients de l'Institut canadien d'information sur la santé. Nous avons extrait les données de toutes les femmes de 19 ans et plus qui ont reçu un diagnostic de cancer du sein entre 2009 et 2014.

Résultats : Nous avons retenu 2346 cas de cancer du sein avec prise en charge chirurgicale. La majorité des interventions (1605, ou 68,4 %) étaient des mastectomies; les autres étaient des CMC. Une analyse de régression logistique a révélé qu'avec chaque augmentation unitaire du stade (de 0 à 4), les femmes devenaient 1,82 fois plus susceptibles d'opter pour la mastectomie (intervalle de confiance [IC] de 95 % 1,64 à 2,02), et 1,15 fois plus susceptibles de le faire avec chaque augmentation unitaire du temps de conduite (IC de 95 % 1,11 à 1,21).

Conclusion : Le stade de la tumeur et le temps nécessaire pour se rendre dans un établissement de radiothérapie étaient des facteurs prédictifs significatifs du choix de traitement chirurgical du cancer du sein chez les femmes de Terre-Neuve-et-Labrador. Fait intéressant : tous les groupes, quels que soient leur âge, le stade de leur tumeur et leur région de la province, avaient une préférence pour la mastectomie. Nous espérons que ces résultats mèneront à d'autres analyses des pratiques chirurgicales locales et contribueront à améliorer la qualité de la prise en charge chirurgicale des femmes atteintes d'un cancer du sein.

Breast cancer is the most commonly diagnosed cancer among Canadian women and the second-leading cause of cancer death.[1] According to the Canadian Breast Cancer Foundation, breast cancer accounted for one-quarter of new female cancers in 2017.[2] Although it remains a serious diagnosis, ongoing improvements in treatment suggest that early-stage breast cancer has a favourable prognosis.[1,3]

A diagnosis of nonmetastatic breast cancer provides most women with a surgical treatment choice: breast-conserving surgery (BCS) (also known as lumpectomy) followed by radiation therapy, or mastectomy.[1] The latter involves removal of the entire breast, whereas in BCS, the cancerous tumour is removed along with a margin of non-cancerous breast tissue. As such, BCS is less invasive than mastectomy. It is associated with better psychosocial outcomes than mastectomy and, when followed by radiation, has comparable survival.[4–7] Thus, if BCS is not contraindicated on clinical grounds, guidelines suggest that women with breast cancer be offered both these surgical options.[8,9]

Given its less invasive nature and comparable survival outcomes, it could be assumed that eligible women would choose BCS. However, wide variation is observed in surgical breast units worldwide[1,10–12] that is not explained solely by case-mix.[13] In Canada, interprovincial variation in surgical treatment choices has been reported: the mastectomy rate ranged from 26% in Quebec to 69% in Newfoundland and Labrador, with an average crude rate of 39%.[3] A special focus report on breast cancer in Canada[1] revealed that, although 80% of Canadian breast cancer cases in 2010 were early stage, Newfoundland and Labrador had a higher proportion (27%) of cases of advanced disease (stage III or IV) at diagnosis than other reporting provinces. The higher mastectomy rate in Newfoundland and Labrador could therefore be, in part, accounted for by the larger proportion of advanced cases.

However, a host of psychosocial and demographic variables also appear to influence breast cancer surgical choices. Younger age and higher education have been associated with increased BCS use,[12,14,15] whereas older women more often chose mastectomy[11] or declined surgery altogether.[14] Attitudes and beliefs about cancer recurrence,[11] odds of survival[16,17] and body image and sexuality,[18,19] as well as fears about radiation therapy,[20] were also associated with surgical decisions.

Geography (rural v. urban residence)[1,21] and the proximity of radiation treatment also appear to affect women's surgical choices. For example, Porter and colleagues[3] found that Canadian women with lengthy travel times to a radiation facility were more likely than those with shorter travel times to undergo mastectomy. In the special focus report on breast cancer in Canada, it was noted that, until driving time exceeded 40 minutes, the mastectomy rate was constant, after which it increased by 7%.[1] The mastectomy rate increased further with additional travel time. In our jurisdiction, Newfoundland and Labrador, a better understanding of geographic influences and treatment availability is particularly salient. The province comprises many rural and remote communities, and there is only 1 radiation treatment facility in the province, located in a tertiary health care centre in the capital city of St. John's.

Understanding the influences on women's surgical choices in breast cancer can encourage informed decisions among women and physicians and promote active communication about treatment. Furthermore, if variables such as geographic proximity to treatment centres and driving time are predictive of treatment decisions, this information is critical for health care spending and service planning. Finally, with the much higher rate of mastectomy in Newfoundland and Labrador,[3] research is needed to better understand this pattern and ensure surgical care is offered appropriately.

The objective of the current study was to document the number of breast cancer diagnoses for a given period in Newfoundland and Labrador and the related surgical treatments that occurred as a result of these diagnoses. We collected demographic, geographic and clinical variables to determine their impact on treatment choice. Stage data were available for the current analyses, an important distinction from the previous Canadian report,[3] in which such data were not available.

Methods

This quantitative analysis was part of a larger study conducted to better understand women's surgical treatment choices for breast cancer in Newfoundland and Labrador. Qualitative data collection is underway with both breast surgeons and women who have made surgical treatment choices. The full study protocol is described elsewhere.[22]

Research questions were both descriptive ("What is the rate of BCS and mastectomy in Newfoundland and Labrador over a 5-year period?") and inferential ("What demographic, geographic and clinical factors are associated with surgery type?"). Given the existing data on the mastectomy rate in the province, we expected that this rate would be higher than that of BCS, even among patients who received their diagnosis at an earlier stage, when BCS is more likely to be a viable treatment option. We hypothesized that stage at diagnosis and residence at diagnosis (i.e., distance from a radiation therapy treatment centre) would be predictors of the surgical procedure received. Recent reviews revealed mixed findings on the effect of age at diagnosis on surgical choice: some studies showed no effect, others showed younger age to be predictive of BCS, while still others showed the opposite trend.[23] We suspect, therefore, that age alone is not a significant predictor of surgical choice.

Study design

We used a retrospective cohort design linking diagnosis data from the Newfoundland and Labrador provincial

tumour registry to surgery data from the Discharge Abstract Database of the Canadian Institute for Health Information. Data were extracted from the tumour registry for all women in whom breast cancer was diagnosed between Jan. 1, 2009, and Dec. 31, 2014. These years included the most up-to-date information, including stage data.

Study variables

Fields extracted from the tumour registry included health care number, sex, date of diagnosis, age and stage at diagnosis (including in situ cases [stage 0]), year of birth, standard geographic code of residence at diagnosis and Regional Health Authority (RHA) of residence at diagnosis. There are 4 RHAs in Newfoundland and Labrador, corresponding to the eastern, central and western regions of the island and Labrador. Eastern Health is the most populous RHA and includes St. John's. The other 3 RHAs have considerably smaller populations, with Central Health being the second most populous, followed by Western Health and Labrador-Grenfell Health. As such, any woman living outside St. John's and undergoing BCS would be required to travel for radiation therapy. This could entail a stay of several weeks. We used the road distance database maintained by the Economic and Statistics Branch of the government of Newfoundland and Labrador to calculate driving distance between the community of residence of a patient and the Health Sciences Centre in St. John's. To present driving time graphically, we divided driving time into 8 categories, from 30 minutes or less to 540 minutes or more. Driving time to the Health Sciences Centre is likely a better indicator of the impact of geography on surgical procedure than RHA of residence, as the latter is a more precise measure of distance travelled to receive radiation therapy. The RHA provides a proxy, but there are communities and towns within the Eastern Health catchment area that are a considerable distance from St. John's.

Patients were excluded if they were male or were aged 18 years or less at diagnosis, or if the diagnosis was made outside the province.

The health care number was used to link patients to the correct surgical information in the Discharge Abstract Database. Fields extracted from the database included surgical procedure code and date of procedure code for all breast resection procedures performed between Jan. 1, 2009, and Dec. 31, 2015. We requested an additional year of data for surgical procedures to enable linkage for procedures performed up to 1 year after the diagnosis date. Procedures are recorded in the Discharge Abstract Database according to the Canadian Classification of Health Interventions coding structure. Codes requested included codes pertaining to BCS (1YM87^–1YM88^) and those pertaining to mastectomy (1YM89^–1YM92^). In line with similar studies,[24] for patients with multiple breast primary tumours diagnosed during the period of interest, the most

advanced cancer diagnosis (identified by stage at diagnosis) that linked to a subsequent surgical procedure was retained for analysis. To code patients according to their most appropriate surgical procedure, we applied the following rules: if a patient linked to BCS only within 365 days of diagnosis, she was coded as having undergone BCS; if a patient linked to mastectomy only within 365 days of diagnosis, she was coded as having received mastectomy; and if a patient linked to BCS but also linked to subsequent mastectomy performed within 1 year of BCS, she was coded as having undergone mastectomy. If a first procedure was recorded more than 1 year after diagnosis, the patient was excluded from analysis. Once the linkage was performed and the data set cleaned, we conducted univariate and multivariate analyses.

Statistical analysis

Univariate analysis included a description of the patient population and related surgical procedures, and χ^2 and Student t test analysis to determine which predictor variables were significantly associated with surgical procedure at the univariate level. Predictor variables significant at $p \leq 0.1$ in univariate analysis were retained for multivariate analysis. We used binomial logistic regression to identify significant predictors of treatment decision at the multivariate level. Following the recent pan-Canadian study,[3] we fit a logistic regression model with independent variables such as tumour stage, age and travel time to the nearest radiation facility to identify predictors of surgical choice. We performed all statistical analyses using SPSS, version 24 (IBM Corp.).

RESULTS

Between 2009 and 2014, 2853 cases of breast cancer were diagnosed in women in Newfoundland and Labrador. There were 5125 related procedures as per the relevant surgical codes. Once the linkage was conducted and the data set cleaned, 2346 cases with a linked surgical procedure remained (Fig. 1). There were no missing data for any variable of interest.

Table 1 presents the demographic, geographic and clinical variables of the patient population. The mean age at diagnosis was 61.4 years, with the largest proportion of women in the 50–59 and 60–69 age groups. A similar proportion of diagnoses occurred each year. Most cancers were diagnosed at an early stage (1999 [85.2%] at stage 0–II). The breakdown of RHA of residence at diagnosis was similar to the proportion of the total population that resides in each RHA with the exception of Labrador-Grenfell Health, which had a slightly lower proportion of the overall diagnoses (4.2%) than the proportion of the provincial population residing in the Labrador-Grenfell region (7%). Most of the operations (1605 [68.4%]) were mastectomy

procedures, with the remainder being BCS. More radical mastectomy procedures were performed than simple mastectomy procedures (952 [40.6%] v. 653 [27.9%]).

Univariate analysis

Comparison of surgical procedure type by stage at diagnosis showed that women with stage 0 breast cancer were proportionally equally as likely to undergo BCS as mastectomy (Fig. 2A). As the stage increased, the disparity between the proportions who underwent BCS versus mastectomy also increased, with mastectomy representing a larger proportion of procedures at each stage. A total of 612 women (64.0%) with stage I disease went on to have mastectomy, compared to 528 women (73.5%) with stage II disease, which represented considerable bias toward mastectomy even for early-stage disease. χ^2 analysis showed a significant association between stage at diagnosis

and surgery type (χ^2 = 145.71, 4 degrees of freedom [df], $p < 0.001$). Comparisons of surgical type further broken down by BCS, simple mastectomy and radical mastectomy revealed that women were more likely to undergo radical mastectomy as stage progressed. This is unsurprising as an overall trend, but the fact that almost 50% (327 [45.5%]) of women with stage II disease at diagnosis had radical mastectomy was of note.

The χ^2 analysis showed that mastectomy was favoured in all RHAs, but, as expected, the disparity between the proportions of women who underwent BCS versus mastectomy increased outside of Eastern Health (Fig. 2B). There was a significant association between type of surgical procedure and RHA of residence at diagnosis: women living farther from the main treatment site were more likely to undergo mastectomy than BCS (χ^2 = 36.52, 3 df, $p < 0.001$).

Figure 2C depicts surgery type by 10-year age group, with the exception of the 2 youngest age groups, which
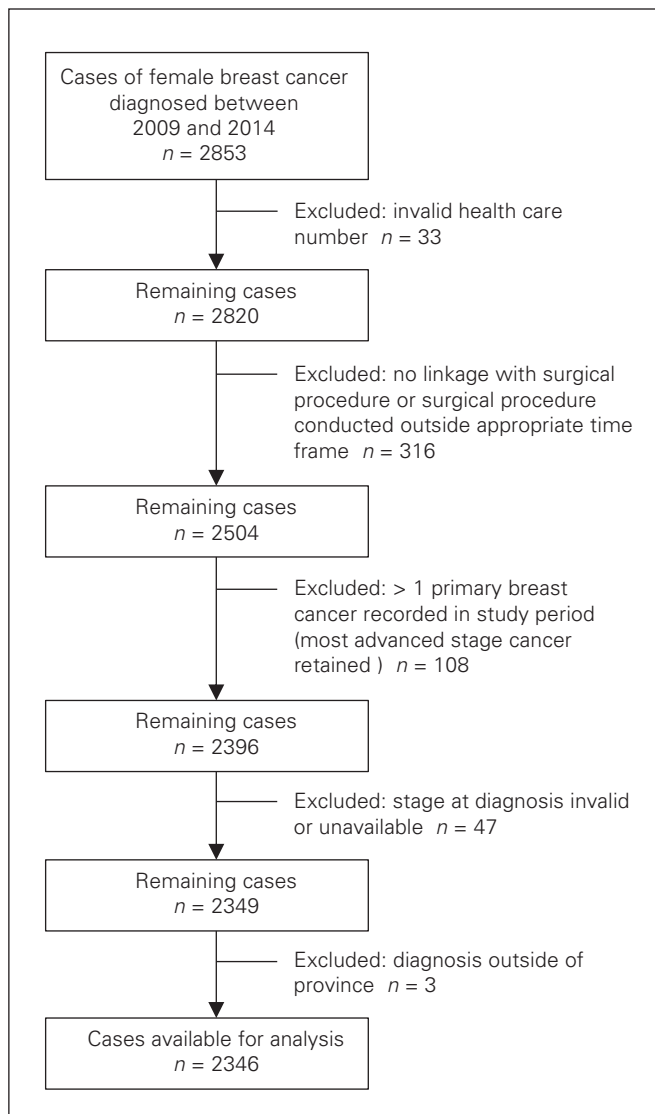
Fig. 1. Flow diagram showing selection of cases for analysis.

Table 1. Demographic, geographic and clinical variables of patient population

| Variable	No. (%) of patients* n = 2346
Age, yr, mean ± SD (range)	61.4 ± 12.2 (25–97)
Age group, yr	
20–29	7 (0.3)
30–39	73 (3.1)
40–49	346 (14.7)
50–59	573 (24.4)
60–69	746 (31.8)
70–79	430 (18.3)
≥ 80	171 (7.3)
Year of diagnosis	
2009	318 (13.6)
2010	383 (16.3)
2011	417 (17.8)
2012	397 (16.9)
2013	441 (18.8)
2014	390 (16.6)
Stage	
0	325 (13.9)
I	956 (40.5)
II	718 (30.6)
III	278 (11.8)
IV	69 (2.9)
Regional Health Authority at diagnosis	
Eastern Health	1373 (58.5)
Central Health	509 (21.7)
Western Health	366 (15.6)
Labrador-Grenfell Health	98 (4.2)
Surgery type	
Breast-conserving	741 (31.6)
Mastectomy	1605 (68.4)
Simple	653 (27.9)
Radical	952 (40.6)

SD = standard deviation.
*Except where noted otherwise.

were collapsed into a single category because of smaller numbers. Women aged 20–39 years were proportionally more likely to undergo mastectomy than women aged 40 years or more. However, mastectomy remained the most common surgery in the latter age group. From age 40–49 onward, the proportion of women who had mastectomy increased in relation to the proportion who underwent BSC (χ^2 = 18.75, 5 df, p < 0.01).

The final variable examined was driving time to the Health Sciences Centre in St. John's. Even for patients residing a short driving distance away from the centre, mastectomy was still the preferred option, although the likelihood of BCS continued to decrease as driving time increased (χ^2 = 90.67, 7 df, p < 0.001) (Fig. 2D).

Table 2 displays a summary of the independent variables tested for their association with surgery type. All
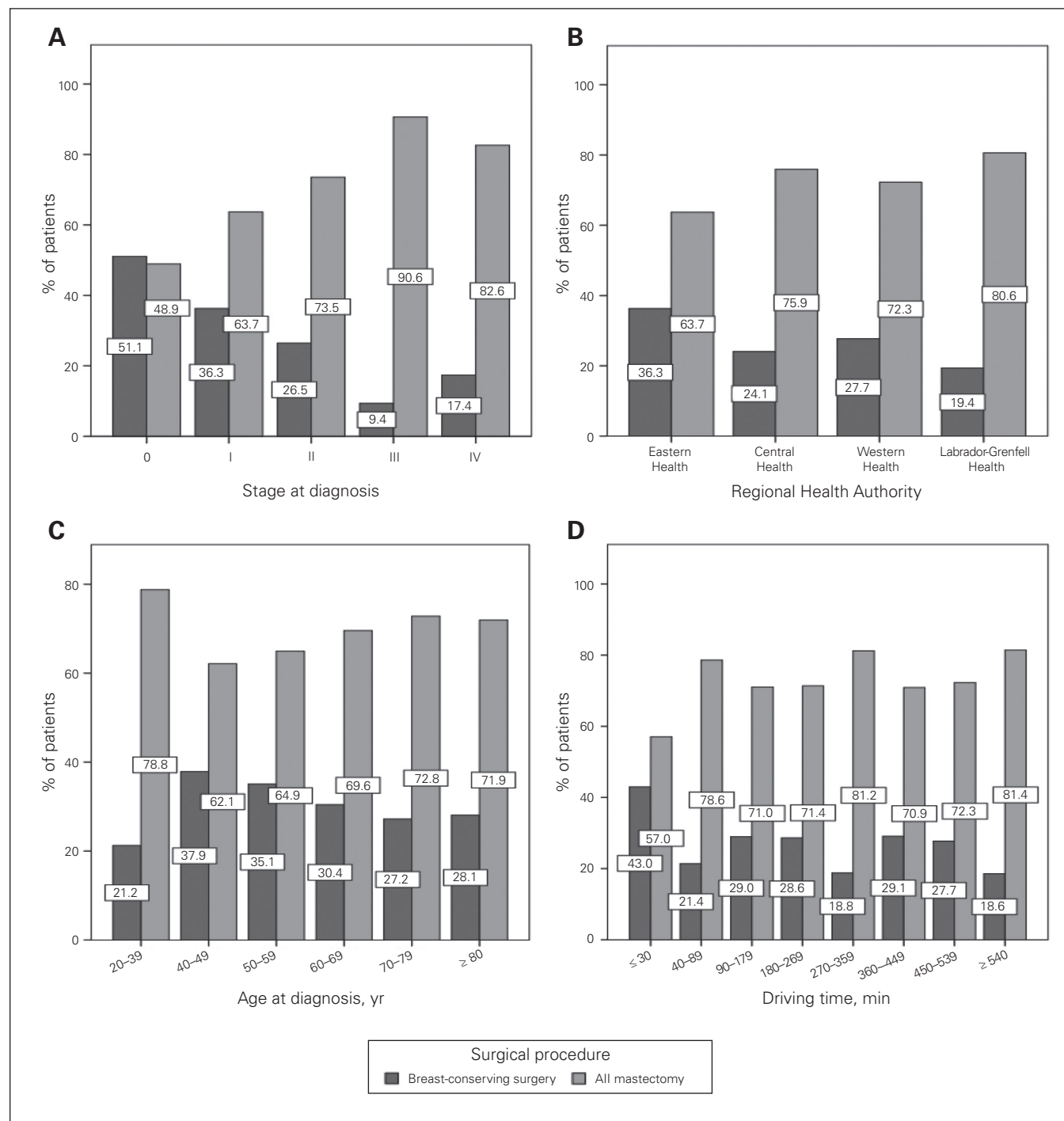
Fig. 2. Surgical procedure (breast-conserving surgery v. all mastectomy) by (A) stage at diagnosis, (B) Regional Health Authority of residence at diagnosis, (C) age group at diagnosis and (D) driving time to radiation treatment centre.

Table 2. Summary of univariate analysis conducted on the relation between demographic, geographic and clinical variables and surgical procedure

Variable*	χ² value	df	p value†
Stage at diagnosis	145.71	4	< 0.001
Regional Health Authority of residence	36.52	3	< 0.001
Age group	18.75	5	< 0.002
Driving time to treatment centre	90.67	7	< 0.001

df = degrees of freedom.
*All retained.

variables tested had a significance level of $p \leq 0.10$, and, as such, all were retained in multivariate analysis.

Multivariate analysis

We conducted logistic regression using surgery type (BCS v. all mastectomy) as the binary dependent outcome. The regression was first run including the 4 variables significant in the univariate analysis. We ran a second regression excluding RHA of residence, as it likely measures a similar construct to driving time. Regression values did not change appreciably with the removal of RHA of residence, so it was left out of the model.

Table 3 shows the logistic regression output when stage at diagnosis, age group and driving time to treatment centre were entered into the logistic regression model. The Wald statistic showed that stage at diagnosis and driving time made a significant contribution to the prediction of surgery choice, but age group did not. Women were 1.82 times [95% CI 1.64–2.02] more likely to have mastectomy for each unit of stage increase from 0 to IV and 1.15 times [95% CI 1.11–1.21] more likely to have mastectomy for each unit of driving time increase. The CIs for both variables were narrow and did not cross 1, which indicated reasonable reliability and significance of the estimate.

DISCUSSION

Although substantial improvements have been made in the treatment of breast cancer, "there are still deficits in the decision-making processes surrounding the surgical treatment of breast cancer."[25] A growing body of literature confirms rising rates not only of mastectomy but also of contralateral prophylactic mastectomy for the treatment of breast cancer.[3,20,23,25–27] Our data clearly show a higher rate of mastectomy across all age groups, tumour stages and geographic areas of the province between 2009 and 2014. A Canadian study analyzing 3 years of data (2007/08 to 2009/10) revealed a mastectomy rate of 69% in Newfoundland and Labrador, compared to 39% for the country.[3] Our results reveal that the high rate of mastectomy in the province extends at least to 2014.

It could be posited that the greater proportion of later-stage tumours in Newfoundland and Labrador[3] may drive the high rate of mastectomy seen in the province. Indeed, stage at diagnosis was a significant predictor of surgery choice in our logistic regression analysis. However, a closer look at our data is revealing. Only 15% of our sample had stage III or IV tumours, and even roughly half of women with stage 0 disease underwent mastectomy. Of those with stage I disease, 64% had mastectomy. These rates show a considerable bias toward mastectomy, even among women with early-stage disease. Based on these findings, it is reasonable to assume that other factors are at play in affecting treatment choice.

Tumour characteristics, including tumour size and lymph node involvement, have been shown to affect surgical choices, such that BCS is associated with smaller tumours and a lack of nodal involvement.[12,24,25] It may be that, in our sample, these tumour characteristics were prevalent and contributed to the high rate of mastectomy seen among women with early-stage disease. It is also possible that an increased awareness of genetic breast cancer syndromes are affecting mastectomy rates in early-stage disease:[25] women at higher risk for these mutations (e.g., *BRCA1* and *BRCA2*) may be choosing mastectomy for treatment of unilateral cancer. Newfoundland and Labrador is well known to have a founder population, with higher than average incidence of several inherited disorders, including inherited cancers.[28] Although we did not have access to mutation status data for this study, nor data on tumour characteristics, these are important variables for future investigation. We also did not request reconstruction data, and future studies should include information on women's use of breast reconstruction following mastectomy in order to provide a more complete picture of surgical choices.

In univariate analyses, age group was significantly associated with surgical choice. As age increased, so did the proportion of women who underwent mastectomy. However,

Table 3. Logistic regression results

Variable	B	SE	Wald statistic	df	p value	Exp(B)* (95% CI)
Stage at diagnosis	0.60	0.05	128.39.07	1	< 0.001	1.82 (1.64–2.02)
Age group	0.09	0.04	5.66	1	0.02	1.10 (1.02–1.18)
Driving time to treatment centre	0.14	0.02	46.36	1	< 0.001	1.15 (1.11–1.21)
Constant	−0.867	0.18	24.16	1	< 0.001	0.41

CI = confidence interval; df = degrees of freedom; SE = standard error.
*Odds ratio.

age was not significant in our multivariate regression model. An inconsistent effect of age on surgical choice has been reported.[23,25] Other studies suggest that younger women are, in fact, more likely to undergo mastectomy or contralateral prophylactic mastectomy than their older counterparts,[27] even after adjustment for tumour characteristics, facility and patient characteristics.[29,30] Indeed, women younger than 35 years were twice as likely to undergo mastectomy as women in their 60s.[30] Thus, although it appears that age alone is not a consistent predictor of surgical treatment choice, research suggests that younger women are choosing mastectomy more often than older patients. Our findings are in line with this trend. Although mastectomy was the most common surgical choice across all age groups, women in the youngest age group (20–39 yr) were proportionally more likely to undergo mastectomy than older women. Our data did not permit investigation of whether younger women had a different prognostic profile than older women, but this is an area worthy of future exploration.

Finally, driving time to the province's only radiation facility was a significant predictor of surgical choice: women were 1.15 times more likely to choose mastectomy for every 40-minute increase in driving time. However, mastectomy remained the most common choice across all categories of driving time. Several studies reveal the influence of geographic location (i.e., proximity to radiation facilities) on surgical choice.[23,25,31,32] Distance to a treatment facility is a variable largely outside patients' control, but it may be important for planners of health care services if service redesign can be considered to mitigate its impact on surgical choice. With improvements in irradiation techniques, including shorter regimens,[23] it is possible that surgical trends could change to favour BCS when possible.

Our data are revealing in the consistent choice of mastectomy across tumour stage, age group and driving distance to a treatment facility. Our findings confirm and extend the high rate of mastectomy in Newfoundland and Labrador[3] and raise questions about how women in the province are exercising their treatment choices and their subsequent quality of care. Our study should provide helpful information for health care funders and planners, as well as clinicians who treat women with breast cancer. Strengths, gaps and opportunities within existing practices might be identified that could collectively improve surgical management of breast cancer.

Our findings likely apply to other types of cancer for which radiation is recommended. Across Canada, radiotherapy is not available in many remote and rural communities. As in Newfoundland and Labrador, radiation facilities are usually located in central sites that serve a large geographical area. We have no reason to believe that the treatment decisions of patients with other cancers who must travel for radiation are unaffected by travel times. Thus, our findings may have implications for planning and patient counselling wherever health care services are delivered to people in rural, remote locations where it is not possible to provide radiation.

In parallel to this quantitative analysis, our team has been interviewing both breast cancer surgeons and women who have made surgical treatment decisions to shed further light on these complex choices. These qualitative data provide the opportunity for a richer interpretation of the factors affecting treatment choice. For example, although driving time to a radiation facility was a significant predictor in our regression model, discussion with women reveals it is not the driving time per se but, rather, the length of time needed to be away from home for treatment. Given child care and other caregiving responsibilities, for some, BCS followed by radiation is not possible. These data are being analyzed and will be reported separately.

Limitations

Our study is limited in the small number of variables available for analysis. Research has shown that other variables, such as fear of cancer recurrence, surgeon's recommendation, body image and sexuality concerns, family and caregiving commitments, also influence surgical choice.[11,16–19,23,32] Surgical treatment choices for breast cancer are complex and are driven by a host of interacting factors. None of these variables were available in the current analysis; nor were other important variables, such as tumour size, lymph node involvement or availability of breast reconstruction services.

CONCLUSION

Tumour stage and driving time to a radiation facility were significant predictors of Newfoundland and Labrador women's surgical treatment choices for breast cancer. However, over a 5-year period, mastectomy was the favoured choice across all age groups, tumour stages and geographical regions of the province. We hope our findings will galvanize efforts to better understand surgical practices and assist in improving the quality of surgical care of women with breast cancer.

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