From evidence to practice: Population-based monitoring of the use of breast-conserving surgery for the treatment of breast cancer using record linkage of routinely collected data

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Abstract

By the early 1990s there was substantial evidence that breast conserving surgery (BCS) plus radiotherapy was an effective but less disfiguring alternative to mastectomy in the treatment of early breast cancer. This study examines trends in and predictors of the use of BCS as opposed to mastectomy in the NSW population.

Methods

Cancer registry records of all cases of breast cancer in women resident in NSW diagnosed in the period 1991 to 1998 were linked using probabilistic techniques with records of breast surgery extracted from hospital separations data for 1991 to 1999. The trend in the proportion of women undergoing BCS was examined and logistic regression was used to examine the influence of geographical remoteness, age, degree of spread, insurance status and hospital throughput.

Results

Between 1991 and 1998, 26,718 NSW women were diagnosed with breast cancer. 25,138 (94%) of these cases were linked with a total of 98,678 hospital admission records. The proportion of metropolitan women who received BCS increased monotonically from 37% to 54%, and from 29% to 43% for rural women. All covariates were significant in predicting the probability of mastectomy versus BCS.

Conclusions

Changes in clinical practice occur slowly across the entire population. The observed increase in the use of BCS will presumably eventually reach a plateau related to the total proportion of women with breast cancer are who are candidates for BCS. The urban/rural difference may be due to relatively poorer access to radiotherapy services for rural women, or it may be due to differences in attitudes to BCS in rural areas.

Introduction

Breast conserving surgery (BCS) has been shown to be an effective method of treatment of breast cancer in its early stages. The surgical procedure involves excision of the primary tumour and adjacent breast tissue, axillary node dissection and followed by radiotherapy.

Over the last decade, there has been an increasing acceptance in Australia of the use of BCS as opposed to mastectomy. A number of randomised controlled trials conducted in the late 1980s and early 1990s established that BCS is just as effective as mastectomy in the treatment of early breast cancer. In addition, it is likely that women undergoing BCS will experience less physical and psychological morbidity post surgery.

The aim of this study is to assess trends in and predictors of the use of BCS in women resident in NSW diagnosed with breast cancer in the period 1991 to 1998. This linkage study uses a similar methodology to our two previous studies on the surgical treatment of breast cancer[1,2]. A validation study on the results the earlier study using linked data from 1991–92 was validated by McGeechan et al.[3]. They found that the record linkage was unbiased with respect to age and geography but under-enumerated the proportion of women receiving BCS. The proportion was 39 per cent in the linked data whereas an estimated true proportion was 42 per cent.

Another important purpose of this study is to demonstrate the utility of probabilistic record linkage of routinely collected data sets for monitoring trends in clinical practice on a population basis. Changes in practice are relatively easy to measure in individual clinical units or practices, but measuring such changes on a population basis has previously required expensive, repeated cross-sectional surveys.

Methods

Population-based data on the surgical treatment of breast cancer were obtained by linking data from the NSW Central Cancer Registry[4] (CCR) data and from Inpatient Statistics Collections[5] (ISC) maintained by the NSW Health Department.

The CCR is a population-based registry. The Registry receives legislatively mandated notifications of all cases of malignant neoplasms in residents of NSW from hospitals, pathology laboratory and deaths certificates.

The ISC includes records for all hospital separations (discharges, transfers and deaths) from all NSW public and private hospitals and day procedure centres, except for some smaller private hospitals prior to July 1992 for which only a known sample of admissions was available. ISC records consist of

a range of demographic data items (eg date of birth, residential address, language spoken at home and country of birth), administrative items (eg admission and separation dates) and coded information (eg reason for admission, significant comorbidities and complications and procedures performed during the admission).

We obtained a file from the CCR data containing the details of all 26,718 cases of malignant breast cancer diagnosed in NSW women between 1991 and 1998. Paget's disease of the nipple and intraductal carcinoma-in-site were excluded. Data items on the CCR file used in the analysis were age at diagnosis, degree of spread, date of diagnosis, area of residence at diagnosis and country of birth. A file of all ISC records relating to breast cancer or breast surgery (including diagnostic procedures) was assembled for the period July 1990 to June 2000, totalling 374,697 records.

Unique personal identifiers simplify the linkage of related, but distinct data collections. In the absence of full identifying information in both data collections, direct linkage of CCR records and ISC records is unable to be achieved through deterministic linkage procedures and more resource-intensive techniques are required. We used Automatch[6] software for this record linkage project. This is a generalised record linkage system based on probabilistic linkage methods[7]. Prior to matching, residential address details from the two sources required standardising. This involved breaking addresses and localities into standardised components derived from existing street and locality patterns using Autostan software.[8]

One-to-many linkage between cancer cases and hospital separations was performed. We specified the CCR records as the reference file, which results in all (matched and unmatched) records being available for each pass of the linkage process, so that many ISC records may match to the same record on the reference file of cancer cases. Data items common to the two data sources were hospital code, medical record number, country of birth, residential address and date of birth. The linkage strategy remained the same as those in our previous linkage studies and is described in more detail there.

Area of residence was assigned to the cancer cases. Metropolitan area health services cover Sydney, Central Coast, Hunter and Illawarra areas. The remaining area health services cover rural areas. An Accessibility/Remoteness Index of Australia[9] (ARIA) value was assigned to each case based on the local government area of residence.

Surgical breast procedures were categorised as breast conserving (ICD–9-CM procedure codes 85.20–85.23 and 85.33–85.36; MBS-E codes 30369–00, 30367–00; MBS-E procedure blocks 1744–1747) or mastectomy (ICD–9-CM procedure codes 85.41–85.48; MBS-E procedure blocks 1748–1751). A small number of records for open breast biopsy were excluded because it was impossible to determine whether the intent of the procedure was diagnostic, therapeutic or both.

Statistical analyses included tests for linear trend and multiple logistic regression.[10] The outcome variable in the logistic regression models was the probability of having a mastectomy (versus breast conserving surgery). Risk factors considered were age at diagnosis (categorised as <60 years or 60+ years), degree of spread at diagnosis (categorised as local spread, regional spread and metastatic spread), ARIA index of remoteness, private health insurance and throughput of breast surgery in the hospitals where surgery was performed categorised as low caseload (<240 procedures), medium caseload (240–569 procedures) and high caseload (570 or more procedures). Cases with unknown degree of spread (n=2,549) were excluded from the data for the logistic regression. The referent levels in the model were women aged less than 60 years, localised spread, no private health insurance and low caseload hospitals.

Results

Record linkage

There were 26,718 women diagnosed with breast cancer during the period 1990 to 1998. Of these cancer cases, 25,138 were linked to ISC records. The overall match rate was 94.1 per cent. The remaining 1,580 cases did not match to any ISC records. This failure to match may have been due to inconsistencies in the recording of matching fields in both data sets, that fact that these women were treated entirely outside NSW, or, in a small number of cases, received no hospital treatment at all. The unmatched cases had a similar age distribution to the linked cases but a higher proportion of them had unknown degree of spread (38 per cent). They were also more likely to be residents in rural health areas that share a border with other States or Territories and thus were more likely to be treated outside NSW. There were 276,019 hospital separations that did not match to CCR records. Principal diagnoses for these separations were mainly chemotherapy (54 per cent) and benign neoplasm of breast (6 per cent).

Hospital admissions

Breast cancer cases were linked to 98,678 hospital separations. Most of the women (79 per cent) were admitted within one month of diagnosis and a further 17 per cent in the second month after diagnosis. The longest gap between initial diagnosis and hospital admission in the linked data was seven years.

Breast procedures

A small proportion of women in the linked cases (7 per cent) had no recorded breast procedures. Of these, the most commonly performed procedure were chemotherapy, blood transfusion, CAT scan, bone scan, thoracocentesis, pulmonary scan and bone marrow biopsy, suggesting that these were advanced cases with metastatic disease. Fifty-five women had radical excision of axillary lymph nodes without mention of a breast procedure.

Table 1 shows trends in the total number of breast procedures for the remaining 23,407 women. There was a significant increase in the number of breast conserving procedures over the eight-year period. The number of mastectomies increased slightly from 1992 to 1995 and then remained constant until 1998. The number of diagnostic breast procedures remained relatively static over the study period.

Year of diagnosis	1991	1992	1993	1994	1995	1996	1997	1998
Breast conserving surgery	1523	1700	2179	2412	2530	2563	2762	3134
Mastectomy	1403	1433	1699	1745	1803	1715	1736	1730
Diagnostic procedures	858	852	984	954	958	929	930	865

Table 1 Breast procedures performed in women diagnosed with breast cancer in 1991–1998

Therapeutic breast procedures

There were 22,400 women who underwent therapeutic breast procedures and they form the main basis of our analysis of surgical treatment patterns. Table 2 shows the number of women undergoing therapeutic breast surgery over the eight-year period. The overall proportion of women who underwent the procedures jumped from 72.3 per cent in 1991 to 84.4 per cent in 1993 but has increased only slightly since then, to 88.4 per cent in 1998.

Year of diagnosis	1991	1992	1993	1994	1995	1996	1997	1998	Total
Breast surgery	2109	2182	2645	2883	2998	3013	3193	3377	22400
Breast cancer cases	2916	2741	3134	3390	3561	3509	3645	3822	26718
Per cent	72.3	79.6	84.4	85.0	84.1	85.9	87.6	88.4	83.8

Table 2 Number of NSW women undergoing therapeutic breast surgery and number diagnosed with breast cancer

Table 3 shows the proportion of women who underwent breast conserving therapy and mastectomy during 1991 to 1998. The proportion of women who had BCS increased steadily from 35.4 per cent in 1991 to 51.7 per cent in 1998. The proportion of women who underwent mastectomy decreased correspondingly over the same eight years, from 64.6 per cent in 1991 to 48.3 per cent in 1998.

Year of diagnosis	1991	1992	1993	1994	1995	1996	1997	1998	Total
BCS only %	35.4	37.1	38.4	41.9	43.2	46.0	48.7	51.7	43.6
Mastectomy %	64.6	62.9	61.6	58.1	56.8	54.0	51.3	48.3	56.4

Table 3 Proportion of women who underwent therapeutic breast surgery by year of diagnosis

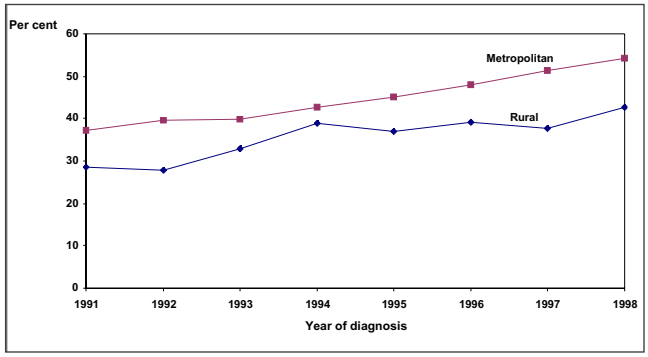

Figure 1 Proportion of breast cancer cases receiving breast conserving surgery

Figure 1 shows the proportion of women receiving breast conserving surgery, broadly grouped by area of residence. There were significant increases in the proportion of women undergoing BCS in both rural and metropolitan areas (p<0.0001). Proportions between the two areas were also significantly different (_^{2} statistic=21.9 with one df, p<0.0001 for rural areas and _^{2} statistic=61.0 with one df, p<0.0001 for metropolitan areas).

Multivariable analysis

In this study, logistic regression models indicated statistically significant associations between the probability of undergoing mastectomy as opposed to BCS and risk factors such as age, degree of spread, ARIA index, health insurance and hospital throughput. Interaction terms between these effects were not found to be statistically significant. The final model, that is, a model with main effects only, gave an adequate fit to the data (Hosmer-Lemeshow goodness of fit statistic=12.5893 with 8 df, p=0.1268).[10] The C statistic[11], a measure of predictive accuracy of the model, was 0.63.

	No.	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age			
<60 years	10387	1.00	1.00
60+ years	9464	1.125 (1.064-1.191)	1.200 (1.119-1.286)
Degree of spread			
Local	12370	1.00	1.00
Regional	7207	2.324 (2.186-2.472)	2.379 (2.208-2.562)
Metastatic	274	1.348 (1.058-1.716)	1.314 (0.982-1.759)
Insurance status			
No private insurance	9845	1.00	1.00
Private insurance	10006	0.842 (0.796-0.891)	0.897 (0.837-0.962)
ARIA	19851	1.147 (1.093-1.204)	1.095 (1.057-1.134)
Hospital throughput			
High caseload	5617	0.742 (0.694-0.793)	0.812 (0.746-0.884)
Medium caseload	4537	0.653 (0.608-0.702)	0.695 (0.634-0.761)
Low caseload	9697	1.00	1.00

Table 4 The likelihood of having mastectomy by patient, tumour, remoteness and hospital characteristics

Table 4 shows the likelihood of undergoing mastectomy as opposed to BCS after adjusting for patient, tumour and hospital characteristics. Older women were more likely to undergo a mastectomy after adjusting for degree of spread, insurance status, remoteness and hospital throughput (odds ratio 1.20, 95 per cent CI 1.12, 1.29). Women with regional spread were more likely to undergo mastectomy than women with localised spread (odds 2.38, 95 per cent CI 2.21,2.56). This is not unexpected, since such cases are generally unsuitable for BCS. Similarly women with metastatic spread were more likely to undergo mastectomy than women with localised spread (odds ratio 1.31, 95 per cent CI 0.98,1.76), but the weaker association with may be due to the use of BCS as a less traumatic alternative in the presence of metastatic disease. Women with private health insurance were statistically significantly less likely to have a mastectomy after adjusting for other variables (odds ratio 0.90, 95 per cent CI 0.84,0.96). Women living in more remote areas were more likely to undergo a mastectomy. The odds ratio for ARIA may appear small, but it is calculated for each unit increase in the index. For example, the most remote local government areas in NSW have an ARIA of 10.752, giving an odds ratio of approximately 2.7.

Women treated in larger hospitals were less likely to undergo mastectomy compared with women treated in smaller hospitals (odds ratio 0.812, 95 per cent CI 0.746, 0.884), after adjusting for other variables. The effect is even less in mid-sized hospitals (odds ratio 0.695, 95 per cent CI 0.634,0.761), possibly due to some residual confounding of degree of spread or insurance status.

Discussion

Some of the benefits derived from this linkage study include:

• Demonstration of a routine mechanism for monitoring patterns of surgical treatment in order to improve hospital outcome for these women diagnosed with breast cancer.

• Demonstration of the utility of linked data to assess trends over periods approaching a decade.

Data quality directly impacts on the success of record linkage projects. In our study transcription errors in identifying fields and dates may have led to some false positive links, that is links between different persons. Transcription errors may also have led to correct matches being missed.

Although we have not formally evaluated the validity of the linkages in this particular study, validation of previous studies using identical methodology suggest that despite these potential shortcomings, the results of the linkage process are probably unbiased.

Like our previous studies[1,2] , this study also showed a clear increase in the use of BCS, with proportions increasing from 35 per cent in 1991 to 52 per cent in 1998. This is probably due to greater acceptance and awareness of the safety and efficacy of BCS by surgeons. Another possible reason is that there is a greater proportion of women being diagnosed earlier due to increase in mammography screening. A study by Kricker[12] on the relationship of tumour size and BCS supports this hypothesis. In addition , the increase may be due to women having greater access to the radiotherapy services that are required as an adjuvant to BCS. At the time of writing, routinely collected data on the utilisation of radiotherapy services at an individual patient level are still not available on a population basis.

The urban/rural difference in the use of BCS which we found previously persists in this study. Women resident in rural areas tend to have a higher probability of undergoing mastectomy as opposed to BCS, even after controlling for age, degree of spread, health insurance status and hospital characteristics. A similar study of Hawaiian women with breast cancer, published recently by Maskarinec et al[13] showed that place of residence was an important risk factor for undergoing mastectomy versus BCS. Women living in the remote and outer islands were less likely to have BCS due to poorer access to the radiation facilities located mainly in the island of Hawaii and Maui.

In this study we are unable to investigate attitudes of patients and surgeons in rural areas towards BCS. Further studies are required to determine whether the observed urban/rural difference is due to poorer access to radiotherapy services in the rural areas, to lack of acceptance of the efficacy of BCS by rural surgeons or to smaller caseloads of breast cancer for each surgeon in the rural areas.

Finally, there has been an overall increase in BCS for the treatment of breast cancer. The relative five-year survival for NSW women diagnosed with breast cancer increased from 77.4% in the period 1985–89 to 83.2% in the period 1990–95[14], which corresponds to the period in which BCS was introduced into mainstream clinical practice. Thus, it seems clear that greater use of BCS represents an improvement in breast cancer care.

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