HEALTH SERVICES RESEARCH

CSIRO PUBLISHING

Australian Health Review, 2012, 36, 342–348
http://dx.doi.org/10.1071/AH11060

Feature

Survival from breast cancer: an analysis of Australian data by surgeon case load, treatment centre location, and health insurance status

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Abstract

Objective. Early invasive breast cancer data from the Australian National Breast Cancer Audit were used to compare case fatality by surgeon case load, treatment centre location and health insurance status.

Method. Deaths were traced to 31 December 2007, for cancers diagnosed in 1998–2005. Risk of breast cancer death was compared using Cox proportional hazards regression.

Results. When adjustment was made for age and clinical risk factors: (i) the relative risk of breast cancer death (95% confidence limit) was lower when surgeons' annual case loads exceeded 20 cases, at 0.87 (0.76, 0.995) for 21–100 cases and 0.83 (0.72, 0.97) for higher case loads. These relative risks were not statistically significant when also adjusting for treatment centre location ($P \geq 0.15$); and (ii) compared with major city centres, inner regional centres had a relative risk of 1.32 (1.18, 1.48), but the risk was not elevated for more remote sites at 0.95 (0.74, 1.22). Risk of death was not related to private insurance status.

Conclusion. Higher breast cancer mortality in patients treated in inner regional than major city centres and in those treated by surgeons with lower case loads requires further study.

What is known about the topic? Studies in some countries show an association of poorer outcomes with lower case load and lack of private health insurance.
What does this paper add? Lower survivals apply in contemporary Australian environments where annual case loads are 20 or fewer and for patients treated in inner regional compared with major city centres. Poorer survivals for patients without private health insurance status are not statistically significant after adjusting for tumour size and other risk factors.
What are the implications for practitioners? Additional research is needed to determine why survivals are lower in Australian settings where case loads are low and when treatment is provided in inner regional centres. Meanwhile, it would be appropriate to target these settings in quality improvement programs.

Received 23 June 2011, accepted 13 December 2011, published online 6 August 2012

Introduction

The National Breast Cancer Audit (NBCA) of the Royal Australasian College of Surgeons (RACS) has collected descriptive data on early breast cancer since 1998. The data support clinical audit by surgeons of their practices and are used for research into breast cancer and its management.[1–5]

The Audit's main purpose is to strengthen quality improvement through the promotion of high clinical standards, but it is recognised that cancer outcomes would also be affected by structural features of the health system, potentially including governance structures, resource allocation, service coordination, workforce availability, and access and appropriateness of care.[6–8] For example, poor survival from cancer among Aboriginal and Torres Strait Islander patients has been associated with geographic remoteness, cultural differences, socioeconomic and other social factors not adequately accommodated by the health system, rather than technical standards of care delivered.[9]

Increasingly, attention is being given around the world to health-system characteristics as determinants of inequalities in outcomes from breast and other cancers.[6,7] This is exemplified by the Organisation for Economic Cooperation and Development (OECD) Health Quality Indicators project which includes cross-national analyses of survival in relation to health-system expenditure, workforce availability, healthcare infrastructure, pharmaceutical pricing, governance arrangements, and other health-system factors.[6,7]

Although the NBCA database includes only limited information on structural features of the health system, it allows assessment of surgeon case load, which would be affected by the distribution of healthcare settings and population size and dispersion. The data also allow classification of treatment location as major city, inner regional and more remote locations, where geographic access to adjuvant treatment services would vary. The data also include information on private insurance status, which is directly relevant to the OECD health quality indicator for expenditure.[6,7]

In this study, we use NBCA data to investigate associations of case load, treatment centre location and insurance status with breast cancer survival in contemporary NBCA settings and consider the policy and research implications. The data relate to cases diagnosed in 1998–2005, with a follow-up of survival to December 2007. The data have good face-value validity in that they show similar survivals to population-based data for early breast cancers from NSW and the USA (Surveillance Epidemiology and End Results (SEER) data).[10–12] Differences in survival by conventional risk factors such as tumour size, grade, nodal status and oestrogen receptor status accord with expected differences, which add credibility to NBCA data.[12–15]

The objective of this study is to determine whether survival differences exist by case load, treatment location and insurance status, and if so, the extent to which differences are attributable to differences in age and clinical risk factors.[16–18] Clinical factors investigated included tumour size, grade, nodal status, oestrogen receptor status, vascular invasion, histology type, and number of breast cancer foci detected.[12–15]

Other studies have reported differences in cancer survival by surgeon and hospital case load, with higher case loads generally being associated with higher survival.[16,19–27] Often these were studies of other cancers, although higher survivals from breast cancer have been linked to higher case loads in North America, Europe, Asia and Western Australia.[28–40] Results have generally been interpreted as reflecting higher skill development from managing higher case loads, although this interpretation has been questioned and alternative explanations suggested, including accompanying differences in degree of specialisation, access to multidisciplinary conferencing, and availability of specialist adjunctive services.[22,33,41]

In the USA, lack of private health insurance can be a barrier to appropriate breast and other cancer care for optimising survival.[18,42] The extent to which this would apply in Australia is uncertain, given universal public health insurance, although differences in outcomes might still apply due to differences in socioeconomic and clinical risk factors or access to care.

NBCA surgeons have had evidence-based clinical guidelines distributed since the mid 1990s and RACS has promoted high standards of care through the NBCA and other means.[2,43] The extent to which variations in case survival exist by case load, treatment centre location and health insurance status in this specialist environment is investigated and research and clinical policy implications considered. The study is novel in producing local evidence of direct relevance to local quality improvement initiatives and research.

Ethics approval for this research was obtained from the Australian Institute of Health and Welfare and RACS research ethics committees.

Methods

NBCA data for Australian women diagnosed with invasive cancer were linked to the National Death Index at the Australian Institute of Health and Welfare using the first three digits of surnames, dates of birth and jurisdiction of residence.[12] A pilot investigation was undertaken in SA, in which data for 1179 women treated by South Australian surgeons were linked with official death records.[12] The accuracy and completeness of the death data so obtained were compared with death information recorded on the South Australian Cancer Registry for the same women where full names were available for linkage purposes and resolution of doubtful links had been undertaken by Registry staff through active follow-up. The results showed a high accuracy of data linkage, with a sensitivity of breast cancer death detection of 93.1%, specificity of 99.9%, predictive value positive of 96.4%, and predictive value negative of 99.8%.[12]

Following the pilot, death data were obtained through the National Death Index for all women recorded on the NBCA database with cancer diagnosed since NBCA data collection commenced in 1998. The date of censoring of live cases for survival analysis was 31 December 2007. Analyses were limited to cancers diagnosed in 1998–2005 to allow enough follow-up time for survival assessment. A total of 31 493 cases were studied after excluding a small number where Australian residency status was uncertain.

Variables analysed as potential predictors of survival in three separate sets of analyses were surgeon case load, treatment centre location and health insurance status. The maximum number of cases recorded on the NBCA for each surgeon per annum was

used to infer case load, which was classified as up to 20, 21–100, or over 100. This was similar to classifications in some other studies, although classification categories have not been consistent across studies.[28–41] Treatment centre location was categorised as major city, inner regional or more remote, using the Australian Standard Geographical Classification.[44] These categories are based on Census Collection Districts (CDs) categorised using the Accessibility/Remoteness Index for Australia (ARIA), which is a measure of the remoteness of a location from the services provided by large towns or cities.[44]

Co-variables used in the analyses and their categorisations are shown in Table 1. Disease-specific survivals from breast cancer were calculated, regarding as a breast cancer death those deaths where breast cancer was recorded as a cause on the death certificate.[45] Disease-specific survival have been shown to correspond closely with relative survival in population-based studies in Australia. For example, breast cancer survivals in SA for 1977–2003 diagnoses were 80% at 5 years from diagnosis, both when using disease-specific and relative survivals, and 70% and 69% respectively at 10 years from diagnosis.[46] Disease-specific survivals are often preferred in clinical studies where, due to referral practices, patients may not have risks of alternative causes of death that are equivalent to population norms (an assumption of relative survival).[13,45,47]

Survival times were calculated from diagnosis to 31 December 2007 or date of death, whichever occurred first. Relative risks of case fatality from breast cancer (i.e. hazards ratios) (95% confidence limits) were calculated by age and clinical characteristics, using Cox proportional hazards regression (unadjusted analysis).[45] Characteristics were expressed as dummy variables using the categories in Table 1. In the second part of the analysis, all clinical variables were entered into the model with age and the principle variable of interest (i.e. case load, treatment centre location or private health insurance status) and backwards elimination used to test whether any could be omitted without significantly ($P < 0.05$) reducing model fit (adjusted analysis). Assumptions of proportionality and lack of co-linearity were checked and satisfied. In supplementary analyses, backward elimination was undertaken also including as a co-variable treatment centre location when investigating case load, case load when investigating treatment centre location, and case load and treatment centre location when investigating health insurance status. Health insurance status was recorded for a limited period in 2003–2005 only and was not available for adjustment on analyses of case load and treatment centre location for 1998–2005.

Table 1. Relative risks (95% confidence limits) of breast cancer death in Australian women with early breast cancer; RACS National Breast Cancer Audit, 1998–2005 diagnosis period

Relative risks were calculated using Cox proportional hazards regression; date of censoring of live cases was 31 December 2007. Relative risks were adjusted for other predictors in the model

Predictors	Relative risks	
	Unadjusted	Adjusted
Age at diagnosis (years.):		
10–39 (reference) [*n* = 1952]	1.00	1.00
40–49 [*n* = 6320]	0.62 [0.51, 0.74]	0.80 [0.66, 0.96]
50–69 [*n* = 16 305]	0.55 [0.46, 0.65]	0.94 [0.79, 1.12]
70–79 [*n* = 4750]	0.94 [0.78, 1.13]	1.64 [1.36, 1.98]
80+ [*n* = 2115]	1.78 [1.46, 2.16]	2.19 [1.79, 2.69]
(Other/unknown [*n* = 51])	(—)	(—)
Histology type:		
Ductal (reference) [*n* = 23 167]	1.00	1.00
Lobular [*n* = 3501]	0.84 [0.72, 0.98]	0.91 [0.77, 1.07]
Other [*n* = 3349]	0.71 [0.60, 0.84]	0.84 [0.71, 0.998]
(Unknown [*n* = 1476])	(1.28 [1.05, 1.57])	(0.56 [0.43, 0.72])
Diameter:		
Under 10 (reference) [*n* = 6958]	1.00	1.00
10–14 [*n* = 4787]	1.50 [1.20, 1.88]	1.37 [1.09, 1.72]
15–19 [*n* = 5682]	1.93 [1.57, 2.36]	1.45 [1.18, 1.79]
20–29 [*n* = 6656]	3.17 [2.63, 3.81]	1.83 [1.51, 2.22]
30–39 [*n* = 2677]	4.70 [3.84, 5.74]	2.30 [1.86, 2.84]
40+ [*n* = 3346]	7.71 [6.42, 9.25]	3.35 [2.75, 4.08]
(Unknown [*n* = 1387])	(5.60 [4.45, 7.04])	(2.40 [1.87, 3.07])
Grade:		
Low (reference) [*n* = 7373]	1.00	1.00
Intermediate [*n* = 12 850]	2.19 [1.81, 2.64]	1.47 [1.21, 1.78]
High [*n* = 9106]	6.21 [5.20, 7.43]	2.59 [2.13, 3.15]
(Unknown [*n* = 2164])	(5.77 [4.67, 7.14])	(2.50 [1.96, 3.18])
Nodal status:		
Negative (reference) [*n* = 17 025]	1.00	1.00
Positive [*n* = 10 331]	3.42 [3.07, 3.81]	1.90 [1.68, 2.14]
(Unknown [*n* = 4137])	(3.74 [3.29, 4.27])	(2.62 [2.27, 3.03])
Oestrogen receptor status:		
Negative (reference) [*n* = 6320]	1.00	1.00
Positive [*n* = 22 753]	0.31 [0.28, 0.34]	0.47 [0.42, 0.52]
(Unknown [*n* = 2420])	(0.69 [0.59, 0.80])	(0.67 [0.55, 0.80])
Vascular invasion:		
Negative (reference) [*n* = 19 669]	1.00	1.00
Positive [*n* = 7072]	3.45 [3.11, 3.83]	1.70 [1.51, 1.91]
(Unknown [*n* = 4752])	(2.40 [2.13, 2.72])	(1.44 [1.25, 1.65])
Number of cancer foci:		
One (reference) [*n* = 23 782]	1.00	1.00
Two [*n* = 2153]	1.08 [0.89, 1.30]	1.04 [0.86, 1.26]
Three [*n* = 2956]	1.77 [1.55, 2.02]	1.29 [1.12, 1.48]
(Unknown [*n* = 2602])	(1.70 [1.47, 1.95])	(1.13 [0.95, 1.34])

Results

Risk factors

Table 1 shows results of Cox proportional hazards regression analyses of age and clinical risk factors. Both unadjusted and adjusted analyses showed predictable increases in risks of breast cancer death with increasing tumour diameter, higher grade, positive nodal status, negative oestrogen receptor status, vascular invasion, and presence of three or more cancer foci. Differences in relative risks for clinical risk factors were generally less pronounced in the adjusted than unadjusted analyses. Lobular cancers had a lower relative risk than ductal histology types in the unadjusted analysis, but less so in the adjusted analysis where statistical significance was not achieved ($P = 0.242$). The pattern by age varied between adjusted and unadjusted analyses, in that

50–69 year olds no longer had a lower relative risk after adjustment than the reference category of women less than 40 years, whereas those aged 70–79 years and over had elevated relative risks. Women aged 40–49 years had a lower relative risk than women below 40 years in both analyses.

Surgeon case load

Unadjusted Cox analysis showed that, compared with the lowest annual case load of up to 20 cases, the relative risk of death (95% confidence limits) was 0.74 (0.65, 0.85) for women treated by surgeons with a case load in the 21–100 range, and 0.70 (0.60, 0.81) for those treated by surgeons with higher case loads (Table 2). The effect of adjusting for age and clinical risk factors was to increase the relative risk to 0.87 (0.76, 0.995) for the 21–100 case load range, and to 0.83 (0.72, 0.97) for higher case loads. When adjustment was also made for treatment centre location, the relative risks became higher at 0.90 (0.78, 1.04) and 0.93 (0.79, 1.09) and were no longer statistically significant ($P \geq 0.15$) (Table 2).

Treatment centre location

Unadjusted Cox analysis showed that compared with major cities, the relative risk of death was elevated at 1.44 (1.29, 1.61) for inner regional locations. Although relative risks were also higher at 1.23 (0.96, 1.57) for more remote locations and 1.24 (0.83, 1.84) for unknown locations, these difference were not statistically significant ($P \geq 0.10$) (Table 2). Adjusting for age and clinical risk factors reduced the relative risk to 1.32 (1.18, 1.48) for inner regional areas compared with major cities. There were not significant differences for more remote locations or unknown locations in the adjusted analysis, with relative risks of 0.95 (0.74, 1.22) and 1.26 (0.85, 1.88) respectively. When adjustment was also made for surgeon case load, little effect on risk estimates for treatment centre location was observed (Table 2).

Health insurance status

A total of 7208 cases were reported to have private health insurance and 4636 cases did not have this insurance during the period when this characteristic was recorded. Unadjusted Cox analysis indicated a higher risk of death for women without private health insurance at 1.41 (1.12, 1.78) (Table 2). After adjustment for age and the clinical risk factors in Table 1, the relative risk reduced to 1.20 (0.95, 1.52) which was not statistically significant ($P = 0.13$). When adjustment was also made for surgeon case load and treatment centre location, the relative risk reduced further to 1.14 (0.90, 1.44) (Table 2).

Discussion

NBCA cases included more localised (node negative) lesions than reported for all female breast cancers at a population level in NSW in 2004–08 (62% compared with 55%), likely reflecting the selection of early breast cancers for inclusion in the NBCA (note, data on extent of cancer at diagnosis are not routinely available from other Australian jurisdictions).[48,49] When numbers of early breast cancers in Australia are estimated from population-based stage distributions observed in NSW, and the USA SEER program,[10,11] it is evident from NBCA data that ~60% would have been covered by the NBCA in 1998–2005.

NBCA data are not population-based and the extent of selection bias for early breast cancers is not known. The extent of bias may not be large, in that survivals of NBCA cases are very similar to corresponding NSW and USA population-based survivals for early breast cancer, and their patterns of survival by conventional clinical risk factors accord with expected patterns.[10,11,50–52] NBCA cases also appear to be broadly similar to all Australian female breast cancer cases in:

(1) Age at diagnosis – e.g. the percentage aged less than 50, 50–69, and 70 years or more respectively equalled 26%,

Table 2. Relative risks (95% confidence limits) of breast cancer death in Australian women with early breast cancer by provider characteristic; RACS National Breast Cancer Audit, 1998–2005 diagnosis period

Relative risks were calculated using Cox proportional hazards regression; date of censoring of live cases was 31 December 2007. Relative risks were adjusted for other age and clinical risk factors (see Table 1). Relative risks adjusted for age, clinical risk factors and in Model 1, also for treatment centre location; in Model 2, also for case load; and in Model 3, also for treatment centre location and case load (see text)

Provider characteristic	Relative Risk		
	Unadjusted	Adjusted	Adjusted for models 1, 2 and 3
Model 1: Annual surgeon case load:			
≤ 20 (Reference) [*n* = 3755]	1.00	1.00	1.00
21–100 [*n* = 18 345]	0.74 [0.65, 0.85]	0.87 [0.76, 0.995]	0.90 [0.78, 1.04]
>100 [*n* = 9393]	0.70 [0.60, 0.81]	0.83 [0.72, 0.97]	0.93 [0.79, 1.09]
Model 2: Treatment centre location:			
Major city (Reference) [*n* = 24 764]	1.00	1.00	1.00
Inner regional [*n* = 5486]	1.44 [1.29, 1.61]	1.32 [1.18, 1.48]	1.31 [1.16, 1.49]
More remote [*n* = 920]	1.23 [0.96, 1.57]	0.95 [0.74, 1.22]	0.94 [0.73, 1.21]
(Unknown [*n* = 323])	(1.24 [0.83, 1.84])	(1.26 [0.85, 1.88])	(1.28 [0.86, 1.90])
Model 3: Private health insurance[A]			
Yes (Reference) [*n* = 7208]	1.00	1.00	1.00
No [*n* = 4636]	1.41 [1.12, 1.78]	1.20 [0.95, 1.52]	1.14 [0.90, 1.44]

[A]Private insurance status recorded for limited period during 2003–2005.

52% and 22%, compared with the corresponding 24%, 51% and 25% reported by population registries for 2006[53]

(2) Grade – e.g. the percentage for low, intermediate and high grade respectively equalled 25%, 44% and 31%, compared with corresponding population-based data from SA for 1998–2005 of 26%, 43% and 31% (note, data on grade are not routinely available from other Australian jurisdictions).[46]

Furthermore, the proportion of NBCA lesions classified as lobular was 12%, equating with the 12% reported by population registries for 2006.[53]

The association between higher surgeon case load and higher survival found both in the unadjusted analysis and the analysis adjusted for age and clinical risk factors, accords with results of most studies in North America, Europe, Asia and Western Australia.[16,28–40] The difference mostly occurred between 21–100 cases per annum and lower case loads, with little difference observed between the 21–100 and higher case loads. Other studies have shown a progressive association between higher case loads and survival, interpreted by some researchers as strengthening evidence of a causal relationship.[28,37]

The reasons for the association of survival with case load are not known. They may include effects of accompanying factors, such as degree of surgical specialisation, access to multidisciplinary conferencing, access to specialist adjunctive services, or other unspecified clinical factors.[22] Also, there would be potential for confounding from differences in co-morbidity, but this could not be investigated with the data available.

Another possible explanation would be differences in primary course of care by case load. We consider investigation of effects of differences in treatment patterns is a complex undertaking beyond the scope of this initial study, warranting separate attention. Notably, the lower relative risks associated with higher case loads (>20 cases per annum) were less pronounced and no longer statistically significant after adjusting for treatment centre location, raising the possibility of confounding from treatment centre effects.

Minimum case loads have been proposed in the UK for performing breast cancer surgery as a quality safeguard.[54] It is important that factors causing the lower relative risks observed in higher case load categories in this study be further investigated, including factors relating to treatment centre location.

Women treated in inner regional areas had lower survivals than those treated in major cities. This persisted after adjusting for age, clinical risk factors and surgeon case load. Supplementary analysis indicated that the percentage of patients receiving radiotherapy as part of the primary course of care was only slightly lower for inner regional than major city centres (i.e. 32% compared with 34% for mastectomy cases and 85% compared with 89% for cases having conservative breast surgery). Meanwhile, a similar proportion had systemic therapies (86% and 87% respectively). The reason for lower survivals in inner regional areas warrants further analysis. Although it would be expected that inner regional treatment centres may have less specialisation and lower access to multidisciplinary teams and specialist adjunctive services than centres in major cities, similar or greater differences might be expected in more remote areas, where adjusted survivals were similar to those for major cities.

Although lack of private health insurance can be a barrier to receiving appropriate breast and other cancer care in the USA,[18,42] this disparity may not apply in Australia due to universal public insurance. The present results provide clear evidence of a lower unadjusted survival in breast cancer patients without private health insurance, but this difference was reduced, and was no longer statistically significant ($P = 0.13$), after adjusting for tumour size and other risk factors. Adjusting in addition for surgeon case load and treatment centre location further reduced differences in survival by private insurance status.

Conclusion

Although differences in risk of case fatality when case loads exceeded 20 per annum were reduced and not statistically significant after adjusting for treatment centre location, this difference warrants further investigation of causal factors, including possible differences in co-morbidity and centre location effects. In addition, the poorer outcome observed for women treated in inner regional centres compared with major city or remote centres requires further study.

Competing interests

The authors declare there are no competing interests.

Acknowledgements

The authors would like to acknowledge the National Breast Cancer Foundation for funding the study. National Breast and Ovarian Cancer Centre would like to acknowledge the input and advice from members of the Advisory Group established for the study. Members included Professor Dallas English and Ms Suellen Williams.

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