ORIGINALES

Variations in use of breast-conserving surgery by patient, hospital characteristics, and region: a multilevel analysis

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We hare analysed the influence of patient and hospital characteristics and region, on the use of breast-conserving surgery (BCS) in Catalonia (Spain).

Data for this study was obtained from the Catalan Hospital Discharge Data Base. The study period was 1995-1998. The Mantel-Haenszel test was used to examine overall trends in the use of BCS. A regression analysis was performed to assess the effect of period adjusted for patient, hospital characteristics, and area of residence on use of BCS, and a multilevel analysis was performed to consider possible associations between individual and aggregate level variables.

BCS was carried out in 43% of women in the period 1995-98 and there was an increasing significant trend in its use. Multilevel analysis showed that age and hospital volume were significant predictors of the use of BCS, and hospitals with higher volumes of activity having higher rates of BCS relative to mastectomy.

Despite the evidence demonstrating the effectiveness of breast conserving surgery, there are still considerable variations in its use, which may be in part due to physician attitudes. Changes in health care organisation to deal with low volume treatments at hospital level should be considered.

Key words: Breast cancer, cancer treatment, patterns of care.

Variaciones en la utilización de la cirugía conservadora de mama por paciente, características del hospital y región: un análisis multinivel

Se ha analizado si influyen las características del paciente, del hospital y de la región en la utilización de la cirugía conservadora de mama (CCM) en Cataluña (España).

Los datos para este estudio se han obtenido de la base de datos del Informe de Alta Hospitalaria. El período de estudio es de 1995-1998. Se utilizó el test Mantel-Haenszel para analizar las tendencias del uso de la CCM. Se realizó un análisis de regresión para evaluar el efecto de período ajustado por paciente, características del hospital y área de residencia en la utilización de la CCM, así como un análisis multinivel para considerar las posibles asociaciones entre las variables individuales y las variables agregadas.

La CCM se llevó a cabo en un 43% de mujeres en el período 1995-1998 y se observó un incremento significativo en su utilización. El análisis multinivel mostró que la edad y el volumen de actividad del hospital eran predictores significativos en la utilización de la CCM y los hospitales con mayor actividad mostraban un mayor porcentaje de CCM con relación a la mastectomía. A pesar de la evidencia que demuestra la efectividad de la cirugía conservadora de mama todavía existen considerables variaciones en su utilización que pueden ser debidos, en parte, a la actitud del

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INTRODUCTION

Breast cancer is the most frequent cancer in women, accounting for 28% of all tumours among women in Catalonia (Spain)[1]. Surgery has been the key strategy in treating the disease. The first pa-

per demonstrating that breast-conserving surgery followed by radiotherapy was as effective as mastectomy in the treatment of small tumours was published in 1977[2] and further studies showed similar results[3,4]. A consensus statement issued by the National Cancer Institute in 1990 recommended breast-conserving surgery followed by radiotherapy as the treatment of choice in the early stages of breast cancer[5].

The diffusion of breast-conserving surgery (BCS) and its concomitant substitution of mastectomy have not, however, been as rapid as might be expected[6-8]. The introduction of a new procedure into clinical practice is considered to be a complex process, that it is not only explained by the quality of the evidence[9,10]. There is also considerable evidence of variation in the rate of use of BCS; such variations have been attributed to region[11], age and socio-economic level[12], hospital location and type of hospital[13], and the characteristics of hospital staff[14]. Due to the fact that some variables associated with the use of BCS relate to individual patients, whilst others, such as hospital or region of residence, operate at aggregate level. Multi-level analysis could be useful in examining variations in use of breast-conserving surgery[15]. At the same time, there have been no studies into variations of use of BCS in Spain. The aim of this study was to assess both the overall trend in the use of breast-conserving surgery in Catalonia (Spain), and variations in use based on patient characteristics, hospital characteristics and region.

METHODS

Data for this study was obtained from the Catalan Health Service's Hospital Discharge Database (CHSHDD). Catalonia is an autonomous region in the north east of Spain with a population of approximately 6 million, and health care provision is the responsibility of the regional government. The CHSHDD was set up in 1994 and provides complete coverage of all public hospitals and a large percentage of private hospitals in Catalonia. All discharged women aged 25 or over with a diagnosis of breast cancer and treated using a surgical procedure were included in the analysis. All women with a diagnosis of breast cancer, either in situ or invasive (International Classification of Disease [ICD] 9: 174), and who had received breast conserving treatment, including lumpectomy, local excision and subtotal mastectomy (ICD 9: 85-20 to 85-23), or mastectomy (ICD 9: 85-4) were included. Women receiving only biopsy or breast reconstruction procedures were excluded. All relevant surgical procedures performed in public hospitals (n = 70), and in those private hospitals included in the data-base (n = 9), during the period 1995-1998 were included.

In order to examine the overall trend in use of BCS during the study period, the Mantel-Haenszel test was used. Mul-

tiple logistic regression analyses were used to analyse trends in use of BCS whilst adjusting for other variables. Independent variables included in the model of patient characteristics were age, and distance from home to the nearest hospital with a radiotherapy unit (only 11 hospitals offer radiotherapy in Catalonia). In the model used to test the influence of different hospital characteristics on the likelihood of receiving BCS, independent variables were volume of hospital activity (number of procedures carried out in a year, classified as follows: less than 30, 30 to 49, 50 to 99 and 100 or more), type of hospital (high technology, reference, or county hospital); public or private hospital, hospital teaching status and hospital radiotherapy availability.

To analyse in conjunction the effect of patient and hospital characteristics, and region, on use of BCS, and to determine the relative contribution of each to variations in use of BCS, a multilevel analysis with three levels was performed[16,17]. The first level included the patient-related variables age and distance to the nearest radiotherapy unit. The second level included the same hospital characteristics as those mentioned above. The third level included the health care region in which the hospital was located. Multilevel analysis was performed only on data extracted from the 1998 hospital discharge database.

The use of breast conserving surgery is a dichotomous variable, so that the two level model takes the form:

$$i = 1,\dots,n_j \text{ women in } j = 1,\dots,J \text{ hospitals}$$
$$p = \text{number of individual level variables}$$
$$q = \text{number of aggregate level variables}$$

1st level (individual level)

$$\log(p_j/1-p_j) = \beta_{0j} + \sum_{k=1}^{p}\beta_{kj}X_{kj}$$

2nd level (hospital level)

$$\beta_{0j} = \alpha_{00} + \sum_{s=1}^{q}\alpha_{0s}C_{sj} + u_{0j} \qquad u_{0j} \sim N(0, \tau_{00})$$

$$\beta_{kj} = \alpha_{k0} + \sum^{q}\alpha_{ks}C_{sj} + u_{kj} \qquad u_{kj} \sim N(0, \tau_{k1}) \qquad \text{cov}(u_{0j}, u_{kj}) = \tau_{0k}$$
$$k = 1,\dots,p$$

where p_j is the probability of using BCS for the ith woman in hospital jth thospital, X_k are the individual variables, C_s are the hospital variables, β_{0j} and β_{kj} are the intercept and slopes for the jth level 2 unit, respectively, α_{00} and α_{k0} are the overall mean intercept and slopes adjusted for hospital characteristics, respectively, α_{0s} and α_{ks} are the regression coefficients associated with the level 2, while u_{0j} and u_{kj} represent level 2 random effects. If the observed variance of the random effects is zero ($\tau_{00} = \tau_{11} = \dots = \tau_{k1} = 0$) then the model reduces to a fixed effects model.

RESULTS

Breast-conserving surgery (BCS) was carried out in 43% women in the period 1995-98. There was an increasing significant trend in the utilization of this treatment, from 36.3% in 1995 to 48.7% in 1998 (table 1). The odds ratio of receiving BCS in 1998 as compared to 1995 was 1.68, after ad-

TABLE 1. **Use of breast-conserving treatment (BCT) by patient and hospital characteristics (1995-1998)**

	Numbers of patients	Distribution (%)	BCT (%)				
			1995	1996	1997	1998	Total
Age							
25-39	794	7.0	44.6	42.6	47.0	46.2	45.1
40-49*	2,268	20.1	42.2	49.4	49.8	53.4	48.8
50-69*	5,221	46.3	39.1	45.6	50.3	55.2	47.8
≥ 70*	2,987	26.5	25.0	27.3	31.3	34.7	29.7
Volumen							
<30	2,097	18.6	35.9	38.1	32.8	36.4	35.8
30-49*	1,714	15.2	32.9	39.6	45.6	40.4	39.9
50-99*	2,480	22.0	36.5	42.2	49.6	55.9	45.5
≥ 100*	4,979	44.2	37.5	43.2	47.4	52.8	45.9
Level							
High technology	3,766	33.4	34.0	43.9	46.1	52.4	44.2
County hospital	2,345	20.8	32.0	39.3	39.8	38.9	37.5
Complementary reference hospital	5,159	45.8	40.3	40.7	46.4	50.1	44.7
Hospital							
Public	10,041	89.1	35.1	41.0	44.7	49.0	42.6
Private	1,229	10.9	45.9	45.3	47.0	46.3	46.1
Radiotherapy unit							
Yes	5,210	46.2	35.4	43.7	47.7	53.5	45.2
No	660	53.8	37.1	39.6	42.6	44.8	41.1
University							
Yes	7,397	65.6	36.9	42.9	46.1	52.0	44.6
No*	3,873	34.4	35.0	38.6	42.8	42.6	39.9
Region							
Lleida*	478	4.2	18.4	36.6	41.0	48.5	37.0
Tarragona	588	5.2	49.6	46.9	42.2	45.3	45.9
Tortosa	207	1.8	26.7	33.3	25.0	34.4	30.4
Girona	820	7.3	44.9	45.7	42.5	44.9	44.4
Costa de Ponent*	1,657	14.7	42.9	55.6	58.0	60.8	54.4
Barcelona Nord i Maresme*	1,034	9.2	20.6	26.8	33.9	35.4	27.6
Centre*	2,020	17.9	39.8	40.2	44.8	48.1	43.4
Barcelona*	4,466	39.6	34.7	39.4	44.8	50.0	42.3
Total*	11,270	100.0	36.3	41.5	45.0	48.7	43.0

* p < 0,05. Test of linear association.

justing for age and hospital volume. The odds ratio for the period was not affected when adjusting for other variables (table 2). However, increased use of this procedure was concentrated in the age group 50-69, where the proportion of women receiving BCS rose from 39.1% to 55.2%, while the percentage of women under 40 undergoing BCS remained stable at around 45%.

TABLE 2. **Association of types of surgery for the period 1995-1998, using logistic regression models**

Year	N	ORc*	IC 95%	ORa**	IC 95%
1995	2,633	1		1	
1996	2,822	1.24	1.12-1.39	1.25	1.12-1.40
1997	2,904	1.44	1.29-1.60	1.44	1.29-1.60
1998	2,911	1.67	1.50-1.86	1.68	1.51-1.88

*Unadjusted *odds ratio*. ** *Odds ratio* adjusted by year, age and volume. Dependent variable: type of surgery (1 = BCT, 0 = mastectomy). p < 0,05 test of linear association.

Table 1 shows that there was virtually no change over the study period in the proportion of BCS performed in low volume hospitals (< 30 procedures per year), while the proportion substantially increased in hospitals with higher volumes of activity, from 36.5% in 1995 to 55.9% in those hospitals performing 50-99 procedures per year. County hospitals in particular were responsible for performing only 20.8% of the total overall number of procedures performed in the study period.

Table 1 also shows that there were marked regional variations in terms of the increasing use of BCS. In the Lleida region, for example, use of BCS increased from 18.4% to 48.5% during the study period, while in the Tortosa region the corresponding increase was only from 26.7% to 34.4%, over the same period. Nevertheless, in most regions BCS currently accounts for almost half of all breast cancer treatments, with the exception of two regions (Tortosa and Barcelona Nord i Maresme), where BCS accounted for only 34.4% and

TABLE 3. **Association between types of surgery and patient and hospital characteristics for the period 1998, using multi-level logistic regression models**

	Multilevel logistic regression	
	ORa*	IC 95%
Level 1		
Agen		
25-39	1	
40-49	1.44	1.03-2.03
50-69	1.42	1.04-1.93
≥ 70	0.63	0.46-0.88
Level 2		
Volume		
< 30	1	
30-49	1.21	0.78-1.88
50-99	2.18	1.31-3.61
≥ 100	1.82	1.13-2.92
Random effects	Variance	p-value
Level 1	1	
Level 2 (hospital)	0.28362	0.000

Odds ratio adjusted by age and volume. Dependent variable: type of surgery (1 = BCT, 0 = mastectomy).

35.4% of treatments for breast cancer, respectively.

After performing multilevel analysis, it was found that the statistically significant association between type of procedure and patient's age was maintained (table 3), with women aged 70 or over being less likely to undergo BCS than women under 40, while women in the middle age group had the highest probability of receiving BCS. The association between BCS and hospital activity volume was also maintained (table 3), with BCS being significantly more frequent in hospitals performing over 50 procedures per year. Even when patient and hospital characteristics were taken into account, however, there was still significant inter-hospital variation regarding BCS use (variance of hospital random effect: 0.28362, p < 0.0001) (table 3). The observed variability among regions was no longer significant when patient characteristics and hospitals were taken into account, and distance to the nearest radiotherapy unit was no longer associated with surgery type. The effect of radiotherapy availability and hospital teaching status also disappeared because of collinearity with volume of activity.

DISCUSSION

This study has shown that there was a significant trend towards an increased use of BCS in women with early stage breast cancer during the years 1995-1998 in Catalonia (Spain). The results also show, however, that increased use of this proce- dure was dependent on both patient age and hospital characteristics. In particular, there was a significantly greater increase in the use of BCS in the 50-69 age group compared to older and younger age groups, and in hospitals performing over 50 procedures per year, compared to those with lower volumes of activity. It is also worth pointing out that the current rates of BCS in most health care regions in Catalonia are similar to those found in other areas[18-20], and reflect estimates that approximately 50% of patients with invasive breast cancer would be candidates for BCS[21].

The age-group in which use of BCS increased most rapidly is also the age-group in which breast cancer screening is being carried out, either in population-based screening programmes aimed at women between 50 and 69 initiated in 1994, or using an opportunistic approach[22]. Thus, there is some evidence that increases in the use of BCS have paralleled implementation of these policies, though a causal relationship cannot be inferred, apart from the obvious fact that tumours found in screening will generally be diagnosed at early stage. Geographic variations in screening prevalence[23] might also help to explain apparent regional differences in use of BCS revealed by the initial regression analysis, although these geographic variations disappeared in the multi-level analysis, suggesting that other factors are stronger determinants in use of the procedure. This observation could be derived from the results of the multi-level analysis performed in this study.

As well as age, the multilevel analysis also indicated that volume of hospital activity was one of the most important determinants of increased use of BCS. Although not specifically examined in this study, physician attitude has been shown to play an important part in determining treatment for early stage breast cancer[11,18,24,25], and is likely to be closely linked with the finding that use of BCS is associated with volume of hospital activity, particularly as it is more likely that high volume hospitals will have a dedicated specialised team that deals with these patients.

On the other hand, the fact that low volume hospitals accounted for 19% of all BCS procedures is also important, given the association between the concentration of resources and increased volume and improved outcomes in BCS[26,27], with one study having demonstrated that reduced risk of death was associated with seeing more than 30 patients per surgeon per year[28]. The results of the present study suggest that approximately 1 in 5 BCS may be being performed in suboptimal conditions, a finding which suggests an urgent need to investigate outcomes in the different

settings, and this would form an important direction for future research. It may also suggest a need to implement clinical networking, which might help to provide a balance between effectiveness, cost-effectiveness and accessibility to standard care[29]. To some extent this has already been achieved in the Catalan health regions, where oncologists are frequently available in county hospitals, either as staff members or part-time consultants.

In terms of limitations, the principal weakness of the present study was the lack of information in the data-base which would be relevant to decision-making on treatment for early stage breast cancer. In particular, it would have been helpful to have data on the stage at diagnosis, and patient preferences regarding treatment. Nevertheless, although the availability of such information would no doubt have made the analysis more precise, it would be unlikely to change the major conclusions of the study, as neither disease stage nor patient preferences would be likely to be sufficiently unevenly distributed across age-groups or hospitals with different volumes of activity to have a significant impact on the study findings.

Some tentative conclusions regarding health policy can be drawn from the data presented. Firstly, although overall rates of use of BCS in Catalonia are probably comparable with rates reported in different studies, there are regional variations (which are more likely to be related to the availability of high volume hospitals, than to regional variation per se) which need to be dealt with. Secondly, and related to this, breast cancer is frequent enough to be diagnosed and treated in county hospitals with a low volume of activity. As it has been demonstrated that specialization of providers results in better outcomes, either in terms of survival or quality of life, and/or in terms of the aesthetic results associated with BCS, some means of ensuring equity of access to specialists needs to be found which takes into account different patterns of care and which ensures that experience in the treatment of breast cancer is appropriately spread. Networking of specialists involved in the care of breast cancer patients might be one answer. Thirdly, and perhaps most importantly, there is a need for a study of BCS outcomes in different hospital settings in Catalonia, a study which could eventually be extended to measure the success of any new measures implemented to improve outcomes in low volume settings.

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profesional. La aplicación de determinados cambios
en la organización de la atención oncológica permi-
tirán obtener unos mejores resultados.

Palabras clave: cáncer de mama, tratamiento del
cáncer, modelos de utilización.