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ORIGINAL ARTICLE

The changing cost of breast cancer care: lessons from a centralised modern cancer centre

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Abstract

Background The cost of new cancer technologies has been the subject of intense debate in recent years. There have been significant advances in therapeutic techniques for breast cancer over the past 20 years. This has been accompanied by the concentration of services in designated cancer centres. The aim of this study was to examine the changing cost of breast cancer management over an 18-year period and identify factors underlying this.

Methods We use breast cancer services data from Galway University Hospital in 1995–1996, 2005–2006 and 2011–2012 to examine the changing pattern of care costs and survival.

Results The number of patients treated for breast cancer rose from 200 in 1995–1996, to 411 in 2005–2006 and 563 in 2011–2012. Two-year survival rose in line with national figures from 84 to 89.78 and 92.07%, in the three-time periods respectively. Adjusting for inflation, the average cost per patient rose from €14,710 (95% C.I., €13,398 to €16,022) in 1995–1996 to €30,405 (95% C.I., €38,620 to €32,189) in 2005–2006, before falling to €14,458 (C.I., €13,343 to €15,572) in 2011–2012. We found significant changes in the pattern of costs, with some rising in relative and absolute terms while others fell as new therapies became available and/or moved off patent.

Conclusion Within an evolving context where services are centralised, new therapies emerge and subsequently come off patent, our understanding of the value of cancer therapies continues to evolve. This has important implications for the evaluation of new therapies and broader policy initiatives in this area.

Keywords Breast · Breast cancer · Breast surgery · Health economics · Oncology

Introduction

As the proportion of health care budgets devoted to cancer has increased [1], so too has discussion of this issue and its implications, including the funding of particular programmes that may be judged to be uneconomical. A number of factors underlie increased expenditures on care. These include increases in the number of persons with cancer—related largely to population ageing [2, 3]—increases in the range of effective treatments available and to which people have access [4]; and increases in the price paid for some of those treatments [5]. Until recently, much of the discussion around increasing expenditure has been negative in tone: questioning for example, the pricing decisions of pharmaceutical companies [5, 6] and the sustainability of increasing expenditures [4]. Indeed, concern regarding expenditure has contributed to concerns regarding the success of the so-called war on cancer, and value for money of investments in cancer care [7, 8]. Some more recent contributions to the literature have been, perhaps, more balanced in their approach: seeking to weigh the value of improvements in survival against increased expenditures on care [9, 10], as well as focusing on longer-term returns on cancer spending [11]. In a similar vein, others have offered more nuanced discussions of the issues, that, in addition to encompassing benefits and costs over different time horizons, draw attention to the heterogeneity of cancers as a disease, and changes in the pattern of costs and benefits of developments in

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care, with respect to these [12]. While opinions in the literature may diverge as to how concerned we should be with respect to rising expenditures, a cursory reading of the literature clearly points to the importance of relating cost to outcomes, to the paucity of good longitudinal data relating costs to outcomes, and to the difficulties in making meaningful comparisons between countries, or generalisations across cancers.

The treatment of breast cancer in Ireland over the last 20 years offers an illustrative example of these issues. In Ireland, the method by which breast cancer is detected and treated has changed dramatically over this time period. Since 2008, breast cancer care has been centralised in eight centres. Prior to this, breast cancer had been treated in 33 hospitals, some with small case numbers, limited expertise, and little performance monitoring and variable outcomes. This centralisation of breast cancer services has not only increased the volume of cancer detection and specialisation, but it has also permitted the deployment of multidisciplinary teams (MDTs) that have been linked to improved care quality [13, 14]. In addition, since 2007, a publicly funded programme of breast cancer screening (Breastcheck) has also been available nationally. This allows for earlier detection and intervention. These changes to the architecture of care have occurred, while advances in surgical, adjuvant and neo-adjuvant therapies have emerged and have been adopted: all impacting on costs and outcomes. Ireland also underwent a major financial crisis and economic downturn—beginning in 2008—which saw a significant reduction in health care spending, and sharpened competition for health care resources: again, a factor impacting on costs.

In this paper, we use data on breast cancer patients treated in Galway University Hospital in 1995–1996, 2005–2006 and 2011–2012 to examine the changing pattern of care costs, as well as survival rates among these patients over an 18-year period. Using data from one centre, collected in a consistent fashion in respect of costs and outcomes, over a time period that spans developments in service organisation, technology and economic conditions, it is possible to offer more informed insights into changes in the value of care, and the factors that have driven this, than has hitherto been possible.

Methods

Data on all patients treated in the symptomatic breast unit of Galway University Hospital, in January 1995–December 1996, January 2005–December 2006 and January 2011–December 2012, were extracted from electronic and hard copies of patient records. Activity on all patients covered the active period of care: a minimum of 12-month postdiagnosis. All patients were discussed at a multidisciplinary meeting from 2004 onwards, and decisions were made according to accepted guidelines (http://www.nccn.org/professionals/physician_gls/f_guidelines.asp#site). Data on care included: initial investigations (mammogram and ultrasound); diagnostic procedures (including fine needle aspiration biopsy, core biopsy and open biopsy); surgery (including mastectomy, wide local excision with or additional without margins, axillary clearance and reconstruction); radiotherapy; hormonal therapies (anastrazole, exemestane, fulvestrant, letrozole, tamoxifen); chemotherapies (capecitabine, carboplatin, cisplatin, cyclophosphamide, docetaxel, doxorubicin, gemcitabine, and paclitaxel); and monoclonal antibodies (bevacizumab, lapatinib, pertuzumab and trastuzumab). As surgical procedures developed over time (for example, with the emergence of sentinel lymph node biopsy (SLNB)), or new procedures became available (for example, risk-reducing prophylactic bilateral mastectomy and salpingoophrectomy in the setting of BRCA mutation carriers), these were added to the range of services provided. Similarly, in respect of adjuvant and neo-adjuvant therapies, as new therapies—chemotherapy, radiotherapy and hormonal therapy (for example, the emergence of aromatase inhibitors in the treatment of hormone receptor positive cancer)—became available, or patterns in the use of existing technologies changed (for example, more targeted use of zoledronic acid in reduced doses), these were captured in the data. This was similarly the case with new tests, such as, Oncotype Dx®, that were added to the range of services provided. In addition to activity (surgery, examinations, etc.) and drugs, details on the length of stay were taken from patient notes.

For 1995–1996 and 2005–2006, unit costs in respect of drugs, were obtained from the hospital pharmacy department, or from the BNF (British National Formulary, adjusted for Irish prices) or MIMS (Monthly Index of Medical Specialities), where this was not possible. This allowed us to factor the following into estimates: differences in the drugs used; combination of drugs used; and duration of exposure at the level of the individual. In the case of activities such as, diagnostics, surgery and radiotherapy, these were based on UK reference costs adjusted for inflation, using PSSRU (Personal Social Services Research Unit) [15] Health Inflation Index, and for purchasing power parity, for use in Ireland. We adjust for inflation in health care costs specifically rather than consumer prices to better reflect changes in health care costs over time [16]. In respect of 2011–2012, indigenous costs were available in respect of all diagnostic and surgical services from the finance department and in respect of drugs from the hospital pharmacy department. The costs associated with radiotherapy were sourced from the corresponding department where patient level costing was calculated based on 2012 data. The cost of inpatient days was based on costs provided by the finance department. The differing costs for each of the time periods were taken into account. To facilitate comparison across years, health care costs were inflated to 2011–2012 prices, as appropriate, using PSSRU Health

Inflation Indices (http://www.cso.ie/px/pxeirestat/Statire/SelectVarVal/Define.asp?maintable=CPA01&PLanguage=0). Based on these data, it was possible to compute all treatment costs, as well as costs by component of care and the proportion of total cost by component of care, using a common year.

In addition to costs, data on patient's stage (TNM) were recorded, as were their vital status in December 2014. It was possible, based on the latter, to construct two-year survival rates for all patients over time, obviously longer in terms of patients treated in 1995–1996 and 2005–2006, though these were not calculated.

Mean costs in total and by component were estimated, together with their 95% confidence intervals for each time period. *t* test for differences in means was undertaken. Two-year survival rates were estimated for women in each of the three-time periods. Multivariate analyses of cost as a function of age, vital status, and stage, were undertaken. Choice of independent variables was guided by treatment need and its likely impact on costs. Older patients, those with more advanced disease and those who died within 2 years of diagnosis, were thought likely to have different needs and consume different levels of resources than those who were younger, with earlier stage disease and better survival. Age was included as a quadratic to allow for possible non-linear relationships between need and age while younger patients may be more resilient than older patients, for example, the capacity of patients to withstand extensive treatment with attendant treatment cost is unlikely to increase indefinitely. A log-linear functional form was chosen over a simple linear model as it offered a superior fit to the data.

In 2011–2012, no reconstruction costs were recorded in respect of four women, for whom reconstruction was recorded to have taken place. Similarly, in 2011–2012, no prophylactic surgery costs were recorded in respect of four (different) women for whom prophylactic surgery was recorded to have occurred. In the main analysis in respect of these eight women, no adjustment was made to estimated costs: reconstruction and prophylaxis, respectively, were assumed not to have given rise to a cost. In sensitivity analysis, reconstruction costs were estimated based on those observed among women who had undergone reconstruction in the database. Similarly, in the case of prophylaxis, costs were estimated, based on those observed in the database for women who had undergone this procedure: adjusted in this case for inflation, as the data had to be taken from a previous period. In 2005 data on the age of 13 women was not recorded.

Given differences in treatment, length of follow-up and the architecture of care, it was not thought appropriate to compare across years in multivariate analysis. With respect to stage, patients were categorised as being either stage 1, 2, 3 or 4, with a base category stage 0.

Results

In Table 1, descriptive statistics for women in each cohort is presented, detailing age, stage and average length of stay (which includes surgery and any admissions related to breast cancer and its treatment, e.g., neutropenic sepsis). In Table 2, mean cost by component of care, as well as in total, are presented, together with the standard errors for the mean; significant differences at the 95% confidence level for each of these variables relative to 2005 are indicated. In Table 3, the results of a multivariate regression of total costs for 2011/12 are presented.

As can be seen from Table 1, the number of women treated for breast cancer increased by over 100% between 1995–1996 and 2005–2006 at UCHG, and by a further 37% between 2005–2006 and 2011–2012. While the average age changed slightly, this was not dramatic, nor was there a discernible pattern over time. Average length of stay fell by more than half: from over 10 days to just over 4 days, before rising to just over 6 days in 1995–1996, 2005–2006 and 2011–2012 respectively. As can also be seen from the table, the percentage of women with stage 3 or 4 disease fell over the study period.

Average total costs to treat individual patients rose from approximately €14,710 (95% C.I., €13,398 to €16,022) in 1995–1996 to €30,405 (95% C.I., €38,620 to €32,189) in 2005–2006, before falling to €14,458 (C.I., €13,343 to €15,572) in 2011–2012. As will be evident from Table 2, the use of surgery as a proportion of total costs fell over the study period, while hormone therapy as a proportion of total costs rose over the same period. This clearly demonstrates the changing patterns of care and costs. Adjusting estimates to include the four women for whom reconstruction costs, and the four women for whom prophylaxis costs were not recorded, as one might imagine, had no material impact on findings (€13,996 (C.I., €12,910–€15,082)).

Two-year survival rates rose from 84 to 89.78 and 92.07%, respectively, over the three-time periods. In Table 3, the

Table 1 Descriptive statistics of patients treated for breast cancer in Galway University Hospital during each of the 3 study periods

	1995/96	2005/06	2011/12
Number of patients	200	411	563
Mean age	58.48	57.70*	60.87
Average length of stay (days)	10.33	4.25	6.16
Stage n (%)			
Stage 0	24(12.0)	56 (13.6)	109 (19.4)
Stage 1	46 (23.0)	77 (18.7)	112 (19.9)
Stage 2	63 (31.5)	166 (40.4)	204 (36.2)
Stage 3	52 (26.0)	70 (17.0)	101 (17.9)
Stage 4	15 (7.5)	42 (10.2)	37 (6.6)

*Age was unavailable for 13 patients in 2005

Table 2 Average cost of breast cancer treatment per patient over three time periods at Galway University Hospital. Figures in parentheses are standard errors. Difference in means based on two-sample *t* tests with equal variances. Other costs include the use of bispohosphonates, monoclonal antibodies (bevacizumab, lapatinib, pertuzumab, trastuzumab), GCSF (granlocyte-colony stimulating factor) and Calcichew

Cost	1995–1996 (€)	2005–2006 (€)	2011–2012 (€)
Initial investigation and diagnosis	2293**	725	383
	(31.95)	(22.01)	(7.19)
Surgery including axillary clearance and reconstruction	5073	5744	2157
	(136.73)	(148.47)	(87.59)
	$P < 0.001$		$P < 0.001$
Chemotherapy	559**	3234	1421
	(79.78)	(174.82)	(195.21)
	$P < 0.001$		$P < 0.001$
Radiotherapy	1647**	6021	2580
	(308.86)	(177.52)	(74.31)
	$P < 0.001$		$P < 0.001$
Hormone therapy	1049**	3888	2880
	(150.69)	(148.64)	(176.15)
	$P < 0.001$		$P < 0.001$
Other costs	855**	9464	2764
	(431.01)	(822.23)	(332.05)
	$P < 0.001$		$P < 0.001$
Length of stay	3325**	1330	1926
	(135.26)	(36.60)	(142.39)
	$P < 0.001$		$P < 0.001$
Oncotyping	0	0	345
			(38.03)
Total costs	14,710	30,405	14,458
	(665.47)	(907.78)	(567.33)
	$P < 0.001$		$P < 0.001$
N	200	411	563

simple linear regression of total costs in 2011–2012 as a function of age, stage, and vital status at 2 years is reported. This table shows the variation in the log of total cost as a function of the variables shown. As can be seen, patients with stage 1 breast cancer cost more than those with stage 0, costs rising with stage 2 to stage 3. While stage 4 patients cost less than those with stage 3, they still remain more expensive than those with stage 0 disease. The table also shows the non-linear relationship between costs and age reflected in the negative coefficient on the quadratic (age squared). No significant relationship is found between death within 2 years and costs in this model. The overall regression is highly significant as evidenced by the F-statistic though it explains only 16% of the overall variation in costs.

Table 3 Regression analysis of log total costs as a function of the variables shown F-Stat(7555) = 54.27, $P < 0.01$; $R^2 = 0.41$, $n = 563$

Variable	Coefficient	*t*-statistics	*P*-value
Constant	5.2548	8.46	$P < 0.01$
Age	0.1092	5.11	$P < 0.01$
Age squared	−0.0010	−5.95	$P < 0.01$
Stage 1	1.1939	8.35	$P < 0.01$
Stage 2	1.5743	12.34	$P < 0.01$
Stage 3	1.6997	11.65	$P < 0.01$
Stage 4	1.6046	7.79	$P < 0.01$
Died within 2 years	−0.1255	−0.75	0.455

Discussion

Significant changes in the detection and treatment of symptomatic breast cancer, as well as in the arrangement of services and the broader context of health care funding, occurred in Ireland over the period 1995–2012. Over the same period, there was a marked reduction in the average cost of breast cancer care, and an improvement in the survival rates among those treated. This improvement in survival rates reflects that of national figures [17]. Differences in cost between patients differentiated by age, stage and vital status are evident and consistent with expectations; those who stand to benefit from

and to tolerate more intensive care have an associated higher cost of care.

While the factors responsible for the significant reduction in cost and improvement in outcomes are difficult to deconstruct, we can, nevertheless, identify those factors that are likely to have made positive contributions, and the nature of those contributions. The centralisation of services increased the potential to achieve economies of scale, related, inter alia, to spreading fixed hospital administration and other overhead costs over a larger number of patients, as well as enhancing the quality of care through greater specialisation, and greater adherence to protocols, associated with the deployment of multidisciplinary teams (the improved survival rate recorded in our data is consistent with improvements reported nationally for 5-year rates, albeit for slightly different years) [17]. Beyond this, reductions in the price of particular aspects of care, and evidence-based rationalisation in the quantity of these used also contributed to the decline in costs, and perhaps improvements in survival rates. Between 2005 and 2011, for example, a number of therapies came off patent including: zoledronic acid, anastrozole, letrozole and taxane. This and marked reductions in the use of several of these—such as zoledronic acid—between 2005 and 2011, produced significant cost savings in chemotherapy and hormone therapy, as is evident in Table 2. The reduction in the cost of radiotherapy as a result of more accurate planning also had a significant impact on the overall decrease in the cost of treatment. The reductions in price occurred within a context of broader financial pressures in Ireland that probably impacted on other aspects of cost, by compelling efficiency gains. Following the financial crisis, between 2009 and 2011, for example, per capita annual health care spending in Ireland fell by 6.6%, with sharp decreases in wages, as well as in pharmaceutical prices (OECD, 2013) [18]. This was in stark contrast to the annual growth rates of 7% experienced between 2000 and 2009. It is worth noting, however, that the designated cancer centres were scrutinised under performance metrics which were implemented to ensure compliance with best practice standards from their inception in 2008.

With respect to surgery, the reduction in costs associated with this component of care is likely to be attributable to the widespread use of breast-conserving surgery in cases where it is possible to achieve tumour-free margins using this technique. Furthermore, the replacement of routine axillary lymph node dissection (ALND) in the earlier years of the study with SLNB which allows accurate staging of the axilla has undoubtedly contributed to this reduction. Although these procedures are routinely performed on a day-case basis, we noted a slight increase in length of stay in the latter years of the study. This increase can be explained by the fact that length of stay was calculated based on all inpatient episodes in the 12-month follow-up period, and was composed of admissions including but not limited to those associated with chemotherapy and its associated complications.

In broader terms, the reduction in average cost and the improvements in outcomes, as reflected in improved survival rates, demonstrate the fallacy of what might be characterised as the defeatist commentary in parts of the literature, in respect of the war on cancer. In Ireland, in respect of breast cancer, the value of services measured in terms of outcomes against cost, has improved significantly. While our analysis clearly shows the complexity of assessing costs within an evolving context in which services are centralised, new therapies emerge, come off patent and the quantities and combinations in which they are used change, and new methods of individualising cancer care are adopted; this in no way detracts from the significant and materially important improvements in the value of breast cancer care achieved. It would be dangerous to generalise these findings to other settings, or in respect of other cancers. Equally though, it would be wrong not to reflect on their implications for new discoveries, or on the signals embedded in previous pricing and reimbursement decisions, in regard to their emergence. New technologies can be expensive when first introduced. This relates to drugs and devices while on patent, as well as to new techniques, whose first appearance may attract a significant economic rent, by virtue of the relatively small numbers skilled in their use. As patents expire and techniques diffuse through teaching, however, the cost associated with these advances can fall, while the benefits in terms of health gain remain, or even increase. Importantly, our findings underscore the danger of using short-term budgeting techniques when promoting new developments: they may serve to stifle technological advances, and deny the benefits they bring over the longer term. Care is therefore warranted in their evaluation, and in the need to consider them in a broader context, in which it must be conceded that our understanding of costs, of outcomes, and the relationship between these, especially in regard to cancer, is continuing to evolve.

A limitation of the study is the absence of Irish unit cost data to monetise resource use in two of the study periods. While UK data have been appropriately transferred for these periods to increase comparability, differences reflecting the prices paid for drug therapies between Ireland and the UK could contribute to the differences in costs over time. Were Ireland to enjoy lower drug costs than the UK in 2011, for example, this could contribute to the fall in total costs reported. Typically, health care costs are higher in Ireland including drugs used in the treatment of breast cancer than in the UK [19]. This would suggest that the use of Irish data for the final period of the analysis would serve to elevate costs dampening the fall observed over time. As Irish unit cost data improves, this is something that could be examined more closely in further research.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors. Data contained in this article pertains to the cost of breast cancer management only. Treatment received by patients was not influenced by this work.

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