International Journal of Technology Assessment in Health Care, **26:2** (2010), 156–162.

doi:10.1017/S0266462310000061

Measuring the influence of colleagues on a consultant team's use of breast conserving surgery

Andrew R. Hoy, Hannah Patrick
National Institute for Health and Clinical Excellence

Bruce Campbell
National Institute for Health and Clinical Excellence and *Peninsula College of Medicine & Dentistry*

Georgios Lyratzopoulos
National Institute for Health and Clinical Excellence and *University of Cambridge School of Clinical Medicine*

Objectives: The aim of this study was to examine potential reasons why the use of breast conserving surgery (BCS) for breast cancer varies substantially between hospital teams in England, and in particular to examine whether colleague influence has a role in influencing BCS rates locally.
Methods: Routinely collected Hospital Episode Statistics (HES) data relating to 420 surgical teams in England who performed more than ten breast cancer operations during the financial year 2006/07 were used to identify predictors of team BCS use. Team BCS rates (as a proportion of all types of breast excision surgery) were subject to a regression analysis that incorporated, as independent variables, a range of patient, organizational, and local demographic factors, as well as the BCS rate of colleagues working alongside them in the same hospitals(s).
Results: After adjusting for the effects of other variables, BCS use by colleagues working in the same hospital(s) was a significant predictor of a team's own BCS rate (standardized $b = 0.224$; $p < .001$), denoting a typical 3 percent increase in a team's BCS rate for every 10 percent increase in the BCS rate of colleagues.
Conclusions: The practice of colleagues seems to have a measurable influence upon a surgical team's BCS usage. Guidance from HTA organizations can set national standards about the use of new techniques and innovations, but dissemination can be either slowed down or accelerated by the influence of local colleagues. A strategy of disseminating guidance through professional networks or "local champions" could be a powerful avenue for change.

Keywords: Diffusion of innovation, Information dissemination, Breast neoplasms, Breast-conserving surgery, Practice guideline

No external sources of funding were received for this research. The authors do not have any financial interests, relationships, or affiliations relevant to the subject matter of this manuscript.

For many women with early stage breast cancer, breast conserving surgery followed by radiotherapy is an alternative to total mastectomy and has comparable survival rates (12). Given a choice between the two, some women may choose a total mastectomy because it makes them feel safer, because it decreases the risk of further surgery, or because they may want to avoid radiotherapy (22), but patients treated by BCS have on average better psychosocial outcomes (37).

The UK's National Institute for Health and Clinical Excellence (NICE) recommended in 2002 (28) that breast cancer patients should be fully informed of all available treatment options. This recommendation was made partially in response to previously observed variation in BCS rates between English hospitals, ranging very substantially between 20 percent and 80 percent. More recently, the first annual report of the National Mastectomy and Breast Reconstruction Audit in 2008 (29) noted that there was still considerable variation between hospitals in the United Kingdom, reiterating concerns raised by other recent commentators (7;12). Guidelines by the Association of Breast Surgery at BASO (British Association of Surgical Oncology) (5) also emphasize informed choice for the patient and choosing surgery of sufficient magnitude to prevent local recurrence.

For many interventions appraised by healthcare technology assessment organizations (such as NICE) a "diffusion" process of the intervention into clinical practice and among networks or communities of practitioners may have been initiated before the time that technology assessment was undertaken. For example, the use of implantable cardioverter defibrillators was already increasing when NICE recommended them (35), as was the use of pimecrolimus and tacrolimus for atopic eczema (23). Local variation in diffusion processes could in part explain the variation in BCS use between hospital teams, over and above the range of clinical or organizational factors already known to cause variation in BCS use (such as patient and tumor factors, and variation in aspects of local health service provision, such as ease of access to radiotherapy for example) (1,18). A surgeon's own attitude toward BCS treatment protocols might be influenced by training or through personal and professional contact with peers, through socialization and networking, and this hypothesis merits further scrutiny. Previous studies suggest that clinicians often prefer personal recommendations from colleagues or clinic networks over other sources of information about new medical technologies and practices (27), and that clinician networks are a powerful means of spreading best practice and innovation (33).

We, therefore, aimed to examine the influence of personal and professional contacts between surgeons on the use of BCS. Detailed data on personal and professional contacts between clinicians are almost impossible to gather on a national level, and, therefore, a proxy measure for professional socialization and networking was developed by looking at teams working at the same hospital site or sites.

METHODS

Data

Hospital Episode Statistics (HES) records relating to National Health Service (NHS) hospital admissions in the whole of England (39) were analyzed to identify inpatient episodes in women with a main diagnosis of malignant neoplasm of breast (ICD-10 code C50) or carcinoma in situ (D05) during a 12-month period between 1 March 2006 and 30 April 2007, which included mastectomy (OPCS 4 code: B27) or breast conserving surgery (OPCS 4 code: B28) anywhere in the HES procedure fields. Male patients with breast cancer were not included in the analysis because their expected treatment pathway would be different. The HES anonymized consultant team code was used to identify activity related to individual surgical ("consultant") teams. In this report the term "surgical team" is used to describe the team of an NHS hospital consultant (in this instance, a specialist breast surgeon) including his/her trainees, along with associated staff.

For each surgical team, a ratio expressing the proportion of BCS in relation to all breast cancer surgery that the team performed during the study period was calculated. Teams performing less than ten breast cancer operations during the study period were excluded from the analysis, to avoid extreme BCS use ratios caused by small patient numbers. A small number of patient episodes that included both breast conserving surgery and full mastectomy were also excluded from the calculation of the consultant team BCS ratios.

Colleague Influence Variable

A surrogate measure of colleague influence was constructed, focusing on current (during the study year) connections with surgical teams they worked alongside in one or more hospitals during the study period. This variable was constructed using a three-stage process. First, the hospital site codes listed in HES records were used to create an inventory listing every hospital site that each individual consultant team had worked in during 2006/07 (some teams had worked in more than one hospital sites). If the hospital site code in HES was missing or miscoded, we used the code of the relevant NHS Hospital Trust (a UK term generally referring to the administrative entity of either a single main hospital or a main hospital with subsidiary site) listed on the HES system, and carried out Internet research to determine at which specific hospital site surgeons employed by these hospital trusts performed breast cancer surgery. Some hospital premises referred to in the inventory had an affiliation with, or were located in close proximity to another hospital. It was not always clear what constituted a separate hospital "site." Hospital site plans and road maps were examined, and two sites were recorded as a single site only if one was completely contained within the grounds of another, or if their sites were contiguous or separated by a single public road. From the initial inventory, a list was created of teams that had worked alongside each other at one or more hospital sites during 2006/07. Finally, to measure the overall level of BCS use that each team was "exposed" to by their colleague teams, the mean BCS rate of their colleague teams was calculated, and became the main variable of interest in this study.

Other Analysis Variables

There are several factors already known to cause variation in BCS use (1;9;10;17;18;20;21;26;40;41), and these needed to be taken into account in the analysis. Many of the factors listed in previous literature relate to local patient demographic characteristics and particular aspects of local health service provision. A surgical team would be subject to the same local patient demographic and local health service characteristics as the teams working alongside them in the same hospital or hospitals. The effect of these other factors could, therefore, provide an alternative explanation as to why the BCS usage rates in a given locality were similar, confounding the potential effect of colleague teams. Only by including these factors in the regression as independent variables can such potential confounding be controlled for. The full list of variables for the present study, how they were operationalized, and references substantiating the choice are described in Supplementary Table 1, which appears online (www.journals.cambridge.org/thc2010012).

Almost all of the variables included in the analysis were suggested as independent predictors of BCS rates by previous literature, but there were three exceptions, these being (i) the proportion of a consultant team's breast cancer surgery patients with a previous hospital admission with a diagnosis of breast cancer (C50) or breast carcinoma in situ (D05) during a period starting more than 60 days before the index admission; (ii) the proportion of a consultant team's breast cancer surgery patients with prior BCS surgery; and (iii) the proportion of a consultant team's breast cancer surgery patients with prior total mastectomy.

In all cases, these three variables were calculated using the fullest extent of usable HES historic data, which extends back to April 1997. These variables were used, because in preliminary testing they were all found to be independent predictors of BCS usage by consultant teams.

It would have been ideal if we could adjust our analysis for cancer stage at diagnosis, but unfortunately stage information is not recorded in the HES system. Nevertheless, as a separate measure of differences in disease severity case-mix, we calculated, for each surgical team, the proportion of their breast cancer surgery patients with just a diagnosis of carcinoma in situ (D05), as opposed to those with a diagnosis of breast cancer (C50).

Hierarchical (blockwise entry) linear regression was used to specifically isolate the impact of the colleague team influence variable, with all other independent variables being entered into the regression first. Regression diagnostics were performed to confirm the reliability of the analysis, checking for multicollinearity and heteroscedasticity.

RESULTS

Dataset

The extracted HES data included 37,510 relevant patient episodes relating to 610 different consultant teams. Of these, 178 teams (who managed a total of 479 breast cancer-related episodes) were excluded because they performed ten or fewer breast surgery operations during the study year. Twelve other teams were also excluded because they did not work at any site with at least one other consultant team doing more than ten breast operations a year. The BCS rate for the remaining 420 consultant teams varied between 0.0 percent and 93.8 percent of all breast surgery operations, and the average of their colleague teams' BCS rates varied from 0.0 percent to 82.0 percent.

Each consultant team worked at an average of 1.27 different hospital sites, and had an average of 2.42 colleague teams with more than ten breast cancer operations a year that worked alongside them at their hospital(s). Each hospital site had on average 2.1 consultant teams that carried out breast surgery operations at some time during the 2006/07 year.

Regression

Table 1 presents the results of the regression analysis. After adjusting for the effect of other factors in step 2 of the regression, the mean BCS rate of colleague teams significantly predicted BCS use by a consultant team, with a standardized beta of 0.224 ($p < .001$). This result suggests that, if a team's consultant teams increased (or decreased) their BCS rate by 10 percent on average, the index team's own rate, all other things being equal, would be expected to increase (or decrease) by approximately 3 percent.

Without the colleague influence variable (step 1), the adjusted R-squared value of the regression model was 0.504, and with it, the adjusted R-squared value was raised to 0.549. The change in the R-squared is significant (F Change = 41.915; $p < .001$), suggesting that colleague influence appears to be a meaningful independent explanatory factor for a team's BCS rate.

As for the other independent variables, Table 1 indicates that after taking into account colleague influence (step 2 of the regression) many other variables included in the regression were significantly associated with BCS usage. More specifically, teams who specialized in breast cancer, or who had higher volume of breast surgery were more likely to have a high BCS rate. Higher BCS usage was also associated with lower patient comorbidity [calculated as the average of their patients' Charlson Comorbidity Index (8;31) scores]. Teams having higher proportions of patients with prior hospital admission (i.e., at least 60 days before) for breast cancer or carcinoma in situ were statistically less likely to have a high BCS rate. Having a high portion of patients with previous BCS was statistically associated with the team having a high BCS rate.

https://doi.org/10.1017/S0266462310000061 Published online by Cambridge University Press

Table 1. Association Between Patient, Tumor and Organisational Variables (Including Practice of Colleague Surgical Teams) and Breast Conserving Surgery Rate[a]

Variable	Standardized beta (β) Step 1 –without colleague influence	Standardized beta (β) Step 2 – with colleague influence
(1) Surgical team characteristics		
Team's breast surgery workload – total cases in a year	0.172***	0.167***
Team's breast cancer specialization – the proportion of the team's patients with breast cancer or carcinoma in situ as primary diagnosis – for the 2006/07 year	0.094*	0.104**
(2) Patient and disease characteristics		
Age of breast cancer patients – proportion of the team's patients under 50	−0.158**	−0.087
Patient comorbidity – average score of the team's breast cancer surgery patients using the comorbidity index of Charlson et al. (8)	−0.101**	−0.106**
Severity – proportion of a team's breast cancer patients with carcinoma in situ only	−0.099*	−0.094*
(3) Hospital or health service factors		
Incidence rate of immediate breast reconstruction – the proportion of each team's mastectomy episodes which featured immediate or near immediate breast reconstruction surgery (i.e. during the same hospital episode)	−0.350***	−0.349***
Proportion of patients of breast cancer screening age – proportion of the team's patients who were aged 50 to 70 (the age range of the screening programme for England)	0.104**	0.136*
Local radiotherapy availability – an estimate based on weighted average for each team of the average number of radiotherapy machines per 100,000 people available in the areas where the team drew their patients from, using data from the UK National Radiotherapy Equipment Survey 2007 (38)	0.130***	0.102**
(4) Community and sociodemographic factors		
Patient socioeconomic status – the proportion of a team's breast cancer surgery patients who lived in areas rated in fifth highest wealth band – measured using the Income Deprivation Domain subscale of the Index of Multiple Deprivation (IMD) for England	0.173***	0.143***
Patient ethnic minority status – the proportion of a team's breast cancer patients who are non-white	0.141**	0.119**
(5) Additional patient history variables		
Breast cancer admission more than 60 days prior – the proportion of a team's breast cancer surgery patients with prior hospital treatment for breast cancer or carcinoma in situ, which took place more than 60 days before present episode	−0.204***	−0.196***
Prior BCS – the proportion of a team's breast cancer surgery patients with prior BCS surgery	0.157***	0.129**
Prior mastectomy – the proportion of a team's breast cancer surgery patients with prior full mastectomy	−0.058	−0.058
(6) Colleague influence		
Colleague team BCS rate – Mean level of BCS use by all other teams who worked at the same site or sites as the team in the 2006/07 year	—	0.224***

[a] $R^2 = .504$ for Step 1; $\Delta R^2 = .045$ for Step 2 ($p < .001$). *$p < .05$; **$p < .01$; ***$p < .001$.

Local hospital or health service factors also predicted BCS usage: a higher rate was significantly associated with higher local availability of radiotherapy, and a higher proportion of patients in the age groups covered by the English breast cancer screening program. Conversely, higher incidence of immediate breast reconstruction (measured as reconstruction happening during the same hospital episode) was a very strong negative predictor of BCS surgery. Finally, the sociodemographic profile of the local population appeared to have an association with type of breast surgery. A more affluent patient population was associated with higher BCS rate. Higher BCS rate was also associated with a higher proportion of non-white patients.

Finally, BCS use was inversely correlated with the proportion of carcinoma in situ–only patients, suggesting that patients with tumor of uncertain behavior (i.e., not

https://doi.org/10.1017/S0266462310000061 Published online by Cambridge University Press

necessarily malignant) were more likely to be treated with total mastectomy. This result is both counterintuitive, and discordant with previous research (18). In further analysis, we identified a systematic coding difference in the proportion of patients diagnosed with carcinoma in situ between urban and rural hospitals (data not shown), which we believe reflects differential coding practices. Therefore, the observed association is likely to be confounded by other variables, and to be spurious.

DISCUSSION

These findings appear to confirm that the clinical practice of consultant teams is influenced by the practices of teams who work alongside them at the same hospital site(s), and that this effect can be detected using routinely collected data.

As well as studies that examine diffusion of medical innovation at the level of whole hospitals (24;32), there has been both quantitative (2;3;6;36) and qualitative research (14;15) into the role of clinician-to-clinician contacts. However, social influence issues have never been examined before with respect to BCS use among clinicians, with the exception of research by Fedeli et al. into the role of clinicians in larger hospitals acting as "early adopters" of the technique (13), and the work of Lazovich et al. (25) who tracked the national growth of the popularity of BCS in the United States after a consensus development conference on the issue. Different HTA organizations have initiated clinical "ambassador" or "fellow" schemes that aim to increase awareness of healthcare technology appraisal recommendations among practitioners, such as the Swedish Council on Technology Assessment in Health Care (SBU) "Ambassador" program (34), or NICE's own Fellowship scheme, announced in October 2009 (http://www.nice.org.uk/getinvolved/nicefellowsandscholars.jsp).

Two limitations of our study deserve particular comment. First, measurement of the effects of professional socialization and networking through a common location is limited and our analysis has focused only on colleagues who worked alongside other consultant teams during a single year. It was not possible to measure any previous (longitudinal or historical) colleague influence, or the influence originating outside these sites, for example the effects of formal regional clinical (cancer) networks. The methodology assumes that teams who work in the same hospital have some professional socialization, even if there might be little contact between teams. In addition, the mean BCS rate of a team's "colleague teams" is intended as a crude overall measure of professional peer-influence, but measuring it using a simple mean across all of a team's colleague teams assumes that all these separate colleague teams exert equal influence on the index team.

The second limitation is that, although we examined the potential influence of many different patient, disease, sociodemographic, and healthcare factors on BCS rate, it remains possible that the observed association with colleague team BCS rate may in fact be confounded by another, not accounted for variable or variables. This could include some unidentified aspect or aspects of local patient sociodemographics, or it could be an artifact of local health service provision, for example regional clustering of BCS expertise in relatively high volume "centers of excellence". Repeating the analysis by excluding those consultant teams in "high volume" hospital centers (defined, for example, as those in the top quartile of activity), or adjusting for hospital-level BCS volume, could serve as sensitivity analysis to examine the potential effect of hospital type or BCS volume on the observed "networking" effect. We plan to conduct this analysis in the future.

We found that a high rate of immediate reconstruction following mastectomy by a surgical team has a strong negative correlation with BCS use by the same team. How should this relationship be understood? One interpretation is that the reconstruction rate calculated for this analysis can be viewed as a measure of reconstruction availability. Possibly this is justified, given that rates of immediate reconstruction vary greatly between different parts of England, and that rates overall are much lower than they could be (29). Low rates in a given area could, for example, reflect shortage of skills or resources for reconstruction procedures. The relationship could, therefore, be interpreted as suggesting that wider availability of immediate reconstruction from a patient's surgical team may lower the threshold of acceptability by women for more extensive breast surgery—a tendency suggested by the qualitative study of Collins et al. (9). An alternative interpretation is that the immediate reconstruction rate is not a measure of availability, and that surgeons skilled in breast reconstruction surgery may have a bias toward recommending relatively more extensive surgery. This finding should perhaps motivate qualitative research to examine these two hypotheses in more depth. A third possibility is that the case load of teams with expertise in breast reconstruction is "skewed" toward more advanced cancers typically requiring total mastectomy. In any case, the low overall rate in absolute terms of immediate reconstruction means that the incidence rate of immediate reconstruction alone is not responsible for most of the observed variation in BCS rates.

There is also substantial variation in local availability of radiotherapy in England (7;30). Variation was also found in the present study which calculated, for each consultant team, an appropriately weighted average number of radiotherapy machines available locally per 100,000 people. Unsurprisingly, given the necessity of radiotherapy following BCS, a low average number of local radiotherapy machines was associated with lower use of BCS. Shortages or longer waiting times for radiotherapy may dissuade both clinicians and patients from BCS use and toward more extensive breast surgery—trading this off against the inconvenience of repeated travel to sometimes distant hospitals, as supported by previous non–UK-based research (1;18).

The present study found that having a high proportion of non-white patients was significantly associated with higher BCS usage. Conflicting findings have been found in non-UK research about the relationship between BCS use and ethnic minority status. Our finding may be because ethnic minority populations tend to reside in urban areas in the UK (11), and, therefore, have a higher likelihood of being treated by larger, more specialized teaching hospitals that may act as centers of excellence for innovation diffusion (16;19), and which also may have easy access to radiotherapy. This can be further examined empirically in future studies.

The findings concord with previous research, supporting a positive association between surgical team BCS rate and the following: volume of activity, team specialization, proportion of screening-detected cancers, lower patient comorbidity, and higher average patient wealth.

In the longer-term, training of new breast surgeons in the United Kingdom has changed significantly over recent years, and this may probably impact on BCS use and on the clinical outcomes. Recent guidance on oncoplastic breast surgery by the Association of Breast Surgery at BASO (4) could also influence BCS rate practice in the future.

Two possible future avenues for investigation include: first, searching for colleague influence effects in the use of other medical techniques; and second, in developing this methodology to try and detect the effects of individual team-to-team knowledge and practice transfer over a period of time.

CONCLUSIONS

At a surgical team level, much apparent variation can be explained by examination of patient demographic and disease characteristics, but also, contextual factors including working alongside other teams in the same hospital site(s).

Consideration of colleague influence is important for HTA organizations who seek to influence clinical practice. More than factual reasoning is needed to change practice, if local colleague judgment seems to be trusted as a source of information, independently of the existence guidance issued by a national body. The other side of the coin, however, is that network influences could potentially be useful for fostering diffusion of practice. National HTA organizations, as well as local health service managers might consider exploring in more detail the use of both formal and informal practitioner networks as a method of disseminating guidance.

SUPPLEMENTARY MATERIAL

Supplementary Table 1
www.journals.cambridge.org/thc2010012

CONTACT INFORMATION

Andrew R. Hoy, MA (Hons) (andrew.hoy@nice.org.uk), Analyst, Centre for Public Health Excellence, MidCity Place, 71 High Holborn, London WC1V 6NA, United Kingdom

Hannah Patrick, MRCP, MFPHM (hannah.patrick@nice.org.uk), Consultant Clinical Adviser, Interventional Procedures Advisory Committee, National Institute for Health and Clinical Excellence, MidCity Place, 71 High Holborn, London WC1V 6NA, United Kingdom

Bruce Campbell, MS, FRCP, FRCS (bruce.campbell@nice.org.uk), Chair, Interventional Procedures Advisory Committee, National Institute for Health and Clinical Excellence, MidCity Place, 71 High Holborn, London WC1V 6NA, United Kingdom; Professor, Peninsula College of Medicine & Dentistry, Universities of Exeter and Plymouth, United Kingdom

Georgios Lyratzopoulos, MD, FFPH, FRCP, MPH, DTM&H, Ptychio latrikes (georgios.lyratzopoulos@nice.org.uk), Consultant Clinical Adviser, National Institute for Health and Clinical Excellence, MidCity Place, 71 High Holborn, London WC1V 6NA, United Kingdom; Clinical Senior Research Associate, Department of Public Health & Primary Care, School of Clinical Medicine, University of Cambridge, Institute of Public Health, Forvie Site, Robinson Way, Cambridge CB2 0SR, United Kingdom

REFERENCES

1. Adelson P, Lim K, Churches T, Nguyen R. Surgical treatment of breast cancer in New South Wales 1991, 1992. *Aust N Z J Surg*. 1997;67:9-14.
2. Anderson JG, Jay SJ. The diffusion of medical technology: Social network analysis and policy research. *Sociol Q*. 1985;26:49-64.
3. Ankem K. Influence of information sources on the adoption of uterine fibroid embolization by interventional radiologists. *J Med Libr Assoc*. 2003;91:450-459.
4. Association of Breast Surgery at BASO; Association of Breast Surgery at BAPRAS; Training Interface Group in Breast Surgery, Oncoplastic breast surgery – a guide to good practice. *Eur J Surg Oncol.* 2007;33(Suppl 1):S1-S23.
5. Association of Breast Surgery at BASO. Surgical guidelines for the management of breast cancer. *Eur J Surg Oncol*. 2009;35(Suppl 1):1-22.
6. Becker MH. Factors affecting diffusion of innovations among health professionals. *Am J Public Health*. 1970;60:294-304.
7. Breast Cancer Clinical Outcome Measures (BCCOM) Project. *Analysis of the management of symptomatic breast cancers diagnosed in 2004*. Birmingham: West Midlands Cancer Intelligence Unit/Breakthrough Breast Cancer; 2007.
8. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *J Chronic Dis*. 1987;40:373-383.
9. Collins ED, Kerrigan CL, Anglade P. Surgical treatment of early breast cancer: What would surgeons choose for themselves? *Eff Clin Pract*. 1999;2:149-151.

https://doi.org/10.1017/S0266462310000061 Published online by Cambridge University Press

10. Cuttuli B, Lemanski C, Fourquet A, et al. Breast-conserving surgery with or without radiotherapy vs mastectomy for ductal carcinoma in situ: French survey experience. *Br J Cancer*. 2009;100:1048-1054.
11. Denham C, White I. Differences in urban and rural Britain. *Popul Trends*. 1998;91:23-34.
12. Dixon JM, Mak C. Predictors of mastectomy in a certified breast center – The surgeon is an independent risk factor. *Breast J*. 2008;14:321-323.
13. Fedeli U, Alba N, Schievano E, et al. Diffusion of good practices of care and decline of the association with case volume: The example of breast conserving surgery. *BMC Health Serv Res*. 2007;7:167.
14. Gabbay J, le May A. Evidence based guidelines or collectively constructed "mindlines?" Ethnographic study of knowledge management in primary care. *BMJ*. 2004;329:1013.
15. Greer AL. The state of the art versus the state of the science: The diffusion of new medical technologies into practice. *Int J Technol Assess Health Care*. 1988;4:5-26.
16. Haddock CC, Begun JW. The diffusion of two diagnostic technologies among hospitals in New York State. *Int J Technol Assess Health Care*. 1988;4:593-600.
17. Hall SE, Holman CD, Hendrie DV, Spilsbury K. Unequal access to breast-conserving surgery in Western Australia 1982–2000. *ANZ J Surg*. 2004;74:413-419.
18. Hiotis K, Ye W, Sposro R, Skinner KA. Predictors of breast conservation therapy: Size is not all that matters. *Cancer*. 2005;103:892-899.
19. Jerome-D'Emilia B, Begun JW. Diffusion of breast conserving surgery in medical communities. *Soc Sci Med*. 2005;60:143-151.
20. Johantgen ME, Coffey RM, Harris DR, Levy H, Clinton JJ. Treating early-stage breast cancer: Hospital characteristics associated with breast-conserving surgery. *Am J Public Health.* 1995;85:1432-1434.
21. Kimmick GG, Camacho F, Balkrishnan R, Anderson R. Patterns of care among breast cancer patients with financial need: Information from a Medicaid-claims and tumor registry linked database. *J Clin Oncol*. 2005;23(Suppl):6037.
22. Kirby RM, Basit A, Manimaran N. Patient choice significantly affects mastectomy rates in the treatment of breast cancer. *Int Semin Surg Oncol*. 2008;5:20.
23. Lacey T. *NICE implementation uptake report: Pimecrolimus and tacrolimus for atopic eczema*. London: National Institute for Health and Clinical Excellence; 2007.
24. Laliberte L, Fennell ML, Papandonatos G. The relationship of membership in research networks to compliance with treatment guidelines for early-stage breast cancer. *Med Care.* 2005;43:471-479.
25. Lazovich D, Solomon CC, Thomas DB, Moe RE, White E. Breast conservation therapy in the United States following the 1990 National Institutes of Health Consensus Development Conference on the treatment of patients with early stage invasive breast carcinoma. *Cancer*. 1999;86:628-637.
26. Mandelblatt JS, Berg CD, Meropol NJ, et al. Measuring and predicting surgeons' practice styles for breast cancer treatment in older women. *Med Care*. 2001;39:228-242.
27. McGettigan P, Golden J, Fryer J, Chan R, Feely J. Prescribers prefer people: The sources of information used by doctors for prescribing suggest that the medium is more important than the message. *Br J Clin Pharmacol*. 2001;51:184-189.
28. National Institute for Clinical Excellence. *Improving outcomes in breast cancer: Manual update*. London: National Institute for Clinical Excellence; 2002.
29. National Mastectomy and Breast Reconstruction Audit Team. *A national audit of provision and outcomes of mastectomy and breast reconstruction surgery for women in England and Wales: First annual report*. Leeds: The NHS Information Centre for health and social care; 2008.
30. National Radiotherapy Advisory Group. *Radiotherapy: Developing a world class service for England*. London: Department of Health; 2007.
31. Nuttall M, Van Der Meulen J, Emberton M. Charlson scores based on ICD-10 administrative data were valid in assessing comorbidity in patients undergoing urological cancer surgery. *J Clin Epidemiol*. 2006;59:265-273.
32. Riley BL, Taylor SM, Elliott SJ. Determinants of implementing heart health: Promotion activities in Ontario public health units: A social ecological perspective. *Health Educ Res*. 2001;16:425-441.
33. Riskin DJ, Longaker MT, Gertner M, Krummel TM. Innovation in Surgery; a historical perspective. *Ann Surg*. 2006;244:686-693.
34. Rentzhog L. SBU's Ambassador Program in Northern Sweden. In Jonsson E, ed. *Effective dissemination of findings from research – a compilation of essays*. Alberta: Institute of Health Economics; 2008:55-67.
35. Sheldon TA, Cullum N, Dawson D, et al. What's the evidence that NICE guidance has been implemented? Results from a national evaluation using time series analysis, audit of patient notes and interviews. *BMJ.* 2004;329:999-1007.
36. Strang D, Tuma NB. Spatial and temporal heterogeneity in diffusion. *Am J Sociol.* 1993;99:614-639.
37. Temple WJ, Russell ML, Parsons LL, et al. Conservation surgery for breast cancer as the preferred choice: A prospective analysis. *J Clin Oncol*. 2006;24:3367-3373.
38. The National Cancer Services Analysis Team. *UK National Radiotherapy Equipment Survey*. http://www.canceruk.net/rtservices/rtequip2007/ (accessed March 2009).
39. The NHS Information Centre for Health and Social Care, Hospital Episode Statistics. [accessed 2009]. HES data is copyright © 2009, Re-used with the permission. All rights reserved.
40. Velikova G, Booth L, Johnston C, et al. Breast cancer outcomes in South Asian population of West Yorkshire. *Br J Cancer*. 2004;90:1926-1932.
41. Zorzi M, Puliti D, Vettorazzi M, et al. Mastectomy rates are decreasing in the era of service screening: A population-based study in Italy (1997–2001). *Br J Cancer*. 2006;95:1265-1268.