Published in final edited form as:

Breast. 2015 October ; 24(5): 618–622. doi:10.1016/j.breast.2015.06.007.

Surgical Margin Reporting in Breast Conserving Surgery: Does compliance with guidelines affect re-excision and mastectomy rates?

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Abstract

Objectives—Margin status is important in guiding decisions to re-excise following breast-conserving surgery (BCS) for breast cancer. The College of American Pathologists (CAP) developed guidelines to standardize pathology reporting; however, compliance with margin documentation guidelines has been shown to vary. The aim of this retrospective study was to determine whether compliance with CAP guidelines affects re-excision and mastectomy rates after BCS with negative margins.

Materials and Methods—We identified 1,423 patients diagnosed with breast cancer between 1998 and 2006 who underwent BCS with negative margins. CAP compliance was categorized as maximal, minimal, or non-compliant. Statistical analyses were performed comparing the frequency of re-excision and mastectomy after initial BCS according to CAP margin reporting guideline compliance. Data were adjusted for provider facility by including a clustering variable within the regression model.

Results—Patients with non-compliant margin reporting were 1.7 times more likely to undergo re-excision and/or mastectomy than those with maximally compliant reporting. Level of compliance was most strongly associated with the frequency of mastectomy; non-compliant margin reporting was associated with a 2.5-fold increase in mastectomy rates compared to maximally compliant reporting. The results did not substantially change when the analyses accounted for clustering at the provider facility level.

Conclusion—Our findings suggest that compliance with CAP guidelines in pathology reporting may be associated with variation in re-excision and mastectomy rates following BCS.

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CONFLICT OF INTEREST STATEMENT

No authors from this study have any conflicts of interest to disclose.

ETHICAL APPROVAL

This study was approved by the Institutional Review Board at the University of Vermont.

Keywords

Breast cancer; surgical margins; re-excision; mastectomy; ductal carcinoma in situ; breast conserving surgery; partial mastectomy

INTRODUCTION

Breast conserving surgery (BCS) is widely considered to be the standard operative approach for treating most patients with early stage breast cancers. It is also one of the most commonly performed cancer procedures in the United States. Approximately 60% to 75% of breast cancer cases are initially treated with BCS [1]. Among these cases, rates of re-excision vary widely across surgeons and institutions (from 0–70% in some reports) even after adjusting for clinical factors [1–6]. The goal of BCS is to achieve adequate surgical margins during the initial surgical resection while optimizing the aesthetic appearance of the breast. Additional surgery with re-excision may not only compromise cosmesis, but also can increase morbidity and costs [7,8] for patients while delaying initiation of appropriate adjuvant treatment. Surgical margin status is considered one of the strongest predictors for local recurrence and an important factor guiding the decision to re-excite [9–14]. It is standard practice to re-excite additional breast tissue for positive margins to reduce the risk of local recurrence [2–5]. The therapeutic decisions for positive margins are relatively straightforward; however, only recently has there been published consensus over what constitutes an adequate negative margin [15,16]. Historically, the criteria for an adequate negative margin had relatively arbitrary thresholds ranging from “no tumor at inked margin” to 10mm or more [12,17]. Although absence of tumor at the inked margin is the current recommendation from national clinical consensus guidelines [15,16], there has been considerable variation in practice patterns among surgeons regarding the decision to re-excite or perform a mastectomy based on margin distance [2,18,19].

While aspects of surgical decision-making are shown to be affected by subjective interpretations of negative margin distance, these decisions may also be affected by variations in the adequacy of pathologic margin status reporting practices. According to protocols established by the College of American Pathologists (CAP), pathologists are required to document the distance to the closest negative margin with further recommendation to include margin distance at all six specimen orientations. Our previous work demonstrated that there is variability in compliance with these guidelines for reporting surgical margin status, with more than a quarter of reports not meeting the minimal CAP requirements for margin reporting and only about a third of reports containing all recommended elements of CAP guideline protocols [20].

To date, there are no studies investigating the relationship between the level of compliance with margin reporting CAP guidelines for negative margins and the surgeon’s decision to re-excite or perform a mastectomy. The objective of this study was to retrospectively review pathology reports documenting negative margins from initial BCS specimens and determine whether compliance with reporting guidelines established by the CAP affects re-excision and mastectomy rates immediately following initial surgery.

METHODS

Data

We used existing data from the Vermont Breast Cancer Surveillance System (VBCSS), which collects demographic, radiology and pathology data for all women receiving breast imaging services in the state of Vermont since 1994 [21]. The VBCSS is part of both the National Cancer Institute's Breast Cancer Surveillance Consortium (<http://breastscreening.cancer.gov/>) and the recently formed Population-based Research Optimizing Screening through Personalized Regimens (PROSPR) program (<http://appliedresearch.cancer.gov/prospr/>). This study was approved by the Institutional Review Board at the University of Vermont.

Study Population

We included women in the VBCSS diagnosed with breast cancer during 1998–2006 whose initial breast cancer surgery was BCS. A total of 2,242 potentially eligible cases were identified. We excluded all reports with one or more positive margins (defined as tumor present at the inked margin) on the initial BCS specimen (N=433), since it is standard practice to re-excise if positive margins are found [2–5, 7–8, 15]. Thus, only cases that had negative margins on the initial pathology report were included in the analysis. Eligible breast cancer cases included diagnoses of invasive breast cancer, ductal carcinoma in situ (DCIS), and mixed invasive/DCIS breast cancer. BCS procedures included any of the following: lumpectomy, excisional biopsy, or partial mastectomy as initial treatment. Cases were excluded if the corresponding pathology report for their initial diagnosis met any of the following criteria: reports from slide reviews (N=49), reports with diagnoses of synchronous primaries (N=20), and reports with no residual tumor found on excision following a positive biopsy (N=317). This yielded a final sample size of 1,423 cases available for analysis. Re-excision and/or mastectomy were considered only for patients who had these procedures immediately following the initial BCS and not for patients who had further surgery for a recurrence. These cases were treated by 63 different surgeons practicing at 18 facilities in Vermont, with pathology reports provided by 53 different pathologists.

Data Collection

Data on patient demographics, including age and ethnicity, are routinely gathered by the VBCSS via questionnaires at patient visits to all mammography clinics in Vermont. Copies of all breast specimen pathology reports interpreted in the state of Vermont are routinely provided to the VBCSS. A variety of quality control procedures are employed during the collection of this pathology data, including validation checks during data entry and active follow-up with facilities regarding patients with imaging recommendations for biopsy for whom we have not received a pathology report. Pathology data from the VBCSS has previously been used in a number of publications regarding breast cancer screening performance and breast cancer risk [22–24]. For this project, a single data abstractor (SP) reviewed pathology reports corresponding to the initial breast conserving surgery for each patient to abstract data on tumor characteristics, surgical margins, and compliance with CAP margin reporting guidelines. For each of the six possible margins, we recorded whether negativity/positivity and margin distance were reported. Margins were categorized as

positive if there was tumor present at the inked margin described in the pathology report and excluded from the analysis.

Using the same approach as in our previous study [20], we categorized reports based on compliance with CAP guidelines. Reports termed “minimally compliant” were those that only reported the distance to the closest negative margin, as *required* by CAP protocols. Reports that were termed “maximally compliant” were those that documented each of the six margins (anterior, posterior, lateral, medial, superior, and inferior) as either positive or negative with a measurement of distance to each negative margin, which is *recommended* by CAP protocols. “Noncompliant” reports were those that did not fulfill minimally compliant criteria (i.e., reports that did not document the distance to the closest negative margin).

Additional collected data included cancer type, tumor grade, and tumor size from pathology reports at the time of initial breast conserving treatment.

Statistical Analysis

We compared the frequency of re-excision and mastectomy based on the level of compliance with CAP margin reporting guidelines. The Cochran-Armitage trend test was used to test for crude trends across the compliance categories. Multivariable logistic regression was used to examine the association between CAP guideline compliance and frequency of re-excision and mastectomy while adjusting for potentially confounding factors identified a priori, including age, calendar year, type of cancer (invasive, DCIS, mixed), tumor grade, and tumor size. We adjusted for provider facility by including a facility identifier as a clustering variable within the regression model to account for potential within-facility correlation. Sensitivity analyses explored the impact of accounting for clustering at the surgeon level rather than the facility level. Significance was defined by two-sided $P < 0.05$. Confidence intervals were reported at the 95% level. Analyses were performed using SAS 9.2 (SAS Institute, Cary, NC).

RESULTS

The mean patient age was 67.0 years and 97% of the study population with known ethnicity were non-Hispanic white (Table 1). Most tumors (44.7%) were mixed invasive carcinoma with DCIS, grade 2 tumors, and measured less than 10 mm (Table 2). Cases which did not undergo re-excision or mastectomy after their initial breast conserving surgery were more likely to be 75 years or older, to have been diagnosed later in the study period, have invasive cancer rather than DCIS, and have higher grade cancers. Of the 1423 cases reviewed, 629 (44%) were maximally compliant, 487 (34%) were minimally compliant, and 307 (22%) were non-compliant with CAP protocols (Table 3).

Table 3 displays the crude frequencies of re-excision and mastectomy following the initial BCS, according to CAP compliance. Among patients with non-compliant reports, 29% underwent re-excision or mastectomy following their initial BCS. In contrast, only 18% of patients with maximally compliant reports underwent re-excision or mastectomy.

As shown in Table 4, the multivariable-adjusted analyses indicated statistically significant differences in the frequency of re-excision or mastectomy according to CAP guideline compliance. Patients with non-compliant reports were 1.69 times (95% CI: 1.15, 2.48) more likely to undergo re-excision or mastectomy, compared to patients with maximally compliant reports. This association was strongest for mastectomy; patients with non-compliant reports were 2.5 times (95% CI: 1.6, 3.8) more likely to undergo mastectomy compared to patients with maximally compliant reports. The trend was less clear for frequency of re-excision alone, although patients with minimally compliant reports were more likely to undergo re-excision compared to patients with maximally compliant reports (OR=1.6; 95% CI: 1.1, 2.4). The results did not substantially change when the analyses accounted for clustering at the surgeon level.

DISCUSSION

Our study suggests that variation in CAP margin reporting compliance may be associated with re-excision and mastectomy rates following initial BCS. Patients with maximally compliant reports tended to have lower rates of re-excision and mastectomy than patients with minimally and non-compliant reports. The trend was strongest for mastectomy rates, with non-compliant reporting associated with a 2.5-fold increased risk of mastectomy (95% CI, 1.6–3.8; $p<0.001$) compared to maximally compliant reporting. In addition, the results did not significantly change when the analyses accounted for clustering. Therefore, the results reflect variation in re-excision rates according to margin reporting beyond that which can be explained by within-facility correlation. There are many factors that contribute to surgical decision-making, and compliance with CAP guidelines appears to influence the decision to re-excise or perform mastectomy for BCS as well. Our study demonstrates an average rate of 17% re-excision and 7% mastectomy after initial surgery. These rates of re-excision and mastectomy fall within the range documented in the literature [1–6], and are similar to a pooled analysis of data from four large institutions, which found that approximately 13% of patients with negative margins underwent at least one re-excision or mastectomy [2]. This study reported that re-excision rates indeed are most elevated among women with closer margins.

We are unaware of other studies investigating the association between compliance with CAP guidelines for margin reporting and re-excision or mastectomy after BCS with negative margins. Based on our present results, it appears that this variation influences surgical decision-making with BCS. It is possible that surgeons may feel more comfortable choosing not to re-excise or perform a mastectomy when more complete margin information is available (i.e., margin orientation and distance from all six orientations). There may be less certainty when only one margin is reported, particularly if its orientation is unknown. Studies have shown that involved anterior margin status appears to confer less risk of local recurrence compared to involved margins at other orientations [25,26]. Indeed, studies have demonstrated that the anatomic orientation of the closest involved margin is associated with re-excision, with higher excision rates observed when the closest margin was a radial margin compared with an anteriorly- or posteriorly-oriented margin [2]. A surgeon's decision to re-excise, therefore, could potentially change based on completeness of information provided on the pathology report.

We previously reported substantial variability in the level of compliance with CAP margin reporting guidelines [20]. The variations in practice patterns were likely due, in part, to a previous lack of published consensus regarding the management of negative but ‘close’ margins. In the landmark clinical trial initially demonstrating equivalence between BCS and mastectomy, the National Surgical Adjuvant Breast and Bowel Project (NSABP) defined negative margins as the absence of tumor cells at the inked edge of a specimen [11]. Subsequent controversy arose among those adopting the NSABP definition of negative margins as sufficient to eliminate additional surgeries versus others who considered close margins synonymous with inadequate margins [27–30]. However, a published statement by the American Society of Breast Surgeons acknowledged that there is insufficient evidence to require mandatory re-excision with a close (<1 mm) or focally involved margin(s) [15]. Furthermore, a recent consensus paper by the Society of Surgical Oncology and American Society for Radiation Oncology reaffirmed the concept of “no tumor on ink” as adequately fulfilling criteria for a negative margin [16]. Given the contemporaneous nature of the consensus statement, it is yet to be determined how it will impact current clinical practice. It is unclear how the rate of re-excision and mastectomy will change under the new guidelines.

It should be emphasized that compliance with CAP guidelines may be affected by multiple factors. In order for the pathologist to accurately evaluate surgical margins, the specimen must be properly oriented by the surgeon in the operating room. The best practice is for surgeons to apply different ink colors or sutures to accurately denote the margins of the excised specimen. In addition, specimen defects and methods involved in specimen processing and fixation may also compromise an accurate assessment of margins independent of compliance with pathology protocols. Standardizing specimen processing from surgeon to pathologist would likely have a beneficial impact on the pathologic analysis of surgical margins.

A limitation to our study is the lack of data concerning additional decision-making factors that influence treatment options. Such factors may include patient preferences or the use of adjuvant therapies. In addition, certain pathological features, such as the extent of the intraductal component of the cancer or the volume of breast tissue involved, may have influenced the decision to re-excite. We have no reason to believe that there would be differential variation in these factors according to CAP guidelines compliance, and they do not appear likely to explain our results. Nonetheless, we are limited in our ability to directly assess the role of margin reporting in subsequent surgical management after initial BCS. It is possible that compliance with reporting guidelines may represent a surrogate marker for other system-level factors influencing re-excision and mastectomy rates. However, the associations we observed persisted after accounting for variation in guideline adherence across facilities.

In conclusion, we found that surgeons may be influenced by the level of compliance in pathology reporting when making decisions about the necessity for additional surgical procedures following initial BCS. Our study suggests that the degree of compliance with CAP guidelines is associated with the rate of re-excision/mastectomy, independent of other clinical factors. Reports that included margin distance at all six orientations (maximally compliant) had lower rates of re-excision and mastectomy, whereas reports that documented

only the closest negative margin distance (minimally compliant) or did not include a measurement of distance (non-compliant) had higher rates of re-excision and mastectomy. This pattern of variation in surgical management has implications for both the cost and quality of care provided to breast cancer patients; however, the influence of new national consensus guidelines on this practice pattern variation is yet to be determined. Further research investigating how the rate of re-excision and mastectomy changes under the new guidelines would be beneficial to understanding the impact of guideline compliance. Ultimately, we believe that improving communication between surgeons and pathologists will help achieve better outcomes in the care of breast cancer patients and that improved margin reporting could reduce re-excision and mastectomy rates following breast conserving surgery.

Acknowledgments

This work was supported by the National Cancer Institute (NCI) (U54 CA163303, P01 CA154292). The VBCSS is part of the NCI's Breast Cancer Surveillance Consortium and the Population-based Research Optimizing Screening through Personalized Regimens (PROSPR) program. The sponsors had no direct role in study design, collection, analysis and data interpretation, or in the writing and decision to submit this manuscript for publication.

References

1. Katipamula R, Degnim A, Hoskin T, et al. Trends in mastectomy rates at the Mayo Clinic Rochester: effect of surgical year and preoperative magnetic resonance imaging. *J Clin Oncol*. 2009; 27(25):4082–4088. [PubMed: 19636020]
2. McCahill L, Single R, Bowles EA, et al. Variability in reexcision following breast conserving surgery. *JAMA*. 2012; 307(5):467–475. [PubMed: 22298678]
3. Kotwall C, Ranson M, Stiles A, Hamann M. Relationship between initial margin status for invasive breast cancer and residual carcinoma after re-excision. *Am Surg*. 2007; 73(4):337–343. [PubMed: 17439024]
4. Waljee J, Hu E, Newman L, Alderman A. Predictors of re-excision among women undergoing breast-conserving surgery for cancer. *Ann Surg Oncol*. 2008; 15(5):1297–1303. [PubMed: 18259820]
5. Menes T, Tartter P, Bleiweiss I, Godbold J, Estabrook A, Smith S. The consequence of multiple re-excisions to obtain clear lumpectomy margins in breast cancer patients. *Ann Surg Oncol*. 2005; 12(11):881–885. [PubMed: 16195834]
6. Morrow M, Jagsi R, Alderman A, et al. Surgeon recommendations and receipt of mastectomy for treatment of breast cancer. *JAMA*. 2009; 302(14):1551–1556. [PubMed: 19826024]
7. Singletary S. Surgical margins in patients with early-stage breast cancer treated with breast conservation therapy. *Am J Surg*. 2002; 184:383–393. [PubMed: 12433599]
8. Swanson G, Rynearson K, Symmonds R. Significance of margins of excision on breast cancer recurrence. *Am J Clin Oncol*. 2002; 25:438–441. [PubMed: 12393979]
9. Fisher B, Anderson S, Bryant J, et al. Twenty-year follow-up of a randomized trial comparing total mastectomy, lumpectomy, and lumpectomy plus irradiation for treatment of breast cancer. *N Engl J Med*. 2002; 347:1233–1241. [PubMed: 12393820]
10. Zavagno G, Goldin E, Mencarelli R, et al. Role of resection margins in patients treated with breast conservation surgery. *Am Cancer Soc*. 2008; 76:259–267.
11. Park C, Mitsumori M, Nixon A, et al. Outcome at 8 years after breast-conserving surgery and radiation therapy for invasive breast cancer: influence of margin status and systemic therapy on local recurrence. *J Clin Oncol*. 2000; 18(8):1668–1675. [PubMed: 10764427]
12. Houssami N, Macaskill P, Marinovich M, Dixon J, Irwig L, Brennan M, Solin L. Meta-analysis of the impact of surgical margins on local recurrence in women with early-stage invasive breast

- cancer treated with breast-conserving therapy. *Eur J Cancer*. 2010; 46(18):3219–3232. [PubMed: 20817513]
13. Newman L, Kuerer H. Advances in breast conservation therapy. *J Clin Oncol*. 2005; 23:1685–1697. [PubMed: 15755977]
 14. Morrow M, Strom E, Bassett L, et al. Standard for breast conservation therapy in the management of invasive breast carcinoma. *CA: Cancer J Clin*. 2002; 52(5):277–300. [PubMed: 12363326]
 15. The American Society of Breast Surgeons. [accessed January 28, 2009] Position Statement on Breast Cancer Lumpectomy Margins. 2013. Available: https://www.breastsurgeons.org/statements/PDF_Statements/Lumpectomy_Margins.pdf
 16. Moran M, Schnitt S, Giuliano A, et al. Society of Surgical Oncology- American Society for Radiation Oncology Consensus Guideline on Margins for Breast-Conserving Surgery with Whole-Breast Irradiation in Stages I and II Invasive Breast Cancer. *Int J Rad Onc*. 2014; 88(3):553–564.
 17. Kauffman M, Morrow M, Minckwitz Gv, Harris J. Locoregional treatment of primary breast cancer: consensus recommendations from an Internal Expert Panel. *Cancer*. 2010; 116:1184–1191. [PubMed: 20087962]
 18. Taghian A, Mohiuddin M, Jagsi R, Goldberg S, Ceilley E, Powell S. Current perceptions regarding surgical margin status after breast-conserving therapy: results of a survey. *Ann Surg*. 2005; 241(4): 629–639. [PubMed: 15798465]
 19. Young O, Valassiadou K, Dixon M. A review of current practices in breast conservation surgery in the UK. *Ann R Coll Surg Engl*. 2007; 89(2):118–123. [PubMed: 17346402]
 20. Persing S, James T, Mace J, Goodwin A, Geller B. Variability in the quality of pathology reporting of margin status following breast cancer surgery. *Ann Surg Oncol*. 2011; 18:3061–3065. [PubMed: 21947586]
 21. Geller B, Worden J, Ashley J, Oppenheimer R, Weaver D. Multipurpose statewide breast cancer surveillance system: the Vermont Experience. *Journal of Registry Management*. 1996; 23:168–174.
 22. Tice JA, O'Meara ES, Weaver DL, Vachon C, Ballard-Barbash R, Kerlikowske K. Benign breast disease, mammographic breast density, and the risk of breast cancer. *J Natl Cancer Inst*. Jul 17; 2013 105(14):1043–1049. [PubMed: 23744877]
 23. Kerlikowske K, Zhu W, Hubbard RA, et al. Outcomes of screening mammography by frequency, breast density, and postmenopausal hormone therapy. *JAMA Intern Med*. May 13; 2013 173(9): 807–816. [PubMed: 23552817]
 24. Braithwaite D, Zhu W, Hubbard RA, et al. Screening Outcomes in Older US Women Undergoing Multiple Mammograms in Community Practice: Does Interval, Age, or Comorbidity Score Affect Tumor Characteristics or False Positive Rates? *J Natl Cancer Inst*. Mar 6; 2013 105(5):334–341. [PubMed: 23385442]
 25. Mullen R, Macaskill E, Khalil A, et al. Involved anterior margins after breast conserving surgery: is re-excision required? *Eur J Surg Oncol*. 2012; 38(4):302–6. [PubMed: 22285907]
 26. McIntosh A, Freedman G, Eisenburg D, Anderson P. Recurrence Rates and Analysis of Close or Positive Margins in Patients Treated Without Re-Excision Before Radiation for Breast Cancer. *Am J Clin Onc*. 2007; 30(2):146–151.
 27. Morrow M, Harris J, Schnitt S. Surgical Margins in Lumpectomy for Breast Cancer- Bigger is not Better. *NEJM*. 2012; 367(1):79–82. [PubMed: 22762325]
 28. Kunos C, Larson L, Overmoyer B, Silverman P, Shenk R, Kinsella T, Lyons J. Breast conservation therapy achieving ≥ 2 mm tumor-free margins results in decreased local-regional recurrence rates. *Breast J*. 2006; 12(1):28–36. [PubMed: 16409584]
 29. Obedian E, Haffty BG. Negative margin status improves local control in conservatively managed breast cancer patients. *Cancer J Sci Am*. 2000; 6(1):28–33. [PubMed: 10696736]
 30. Houssami N, Macaskill O, Marinovich ML, Dixon JM, Irwig L, Brennan ME, Solin LJ. Meta-analysis of the impact of surgical margins on local recurrence in women with early-stage invasive breast cancer treated with breast-conserving therapy. *Eur J Cancer*. 2010; 46(18):3218–3232.

Table 1

Demographic characteristics of study subjects.

Demographic Characteristics	All subjects		Re-excision/mastectomy		No re-excision/mastectomy	
	No.	%	No.	%	No.	%
Age at procedure, y						
44	50	3.5	20	6.1	30	2.7
45–54	187	13.1	53	16.1	134	12.3
55–64	384	27.0	96	29.1	288	26.4
65–74	398	28.0	98	29.7	300	27.5
75	404	28.4	63	19.1	341	31.2
Race/ethnicity						
Hispanic	8	0.6	1	0.3	7	0.6
White	1159	81.5	285	86.4	874	80.0
Black	3	0.2	0	0.0	3	0.3
Asian	4	0.3	0	0.0	4	0.4
Native American	5	0.4	2	0.6	3	0.3
Mixed or Other	16	1.1	5	1.5	11	1.0
Missing	228	16.0	37	11.2	191	17.5
Year of initial surgery						
1998–2000	426	29.9	118	35.8	308	28.2
2001–2003	356	25.2	87	26.4	271	24.8
2004–2006	639	44.9	125	37.9	514	47.0

Table 2

Clinical characteristics of cancer diagnoses.

Clinical Characteristics	All subjects		Re-excision/mastectomy		No re-excision/mastectomy	
	No.	%	No.	%	No.	%
Cancer type						
Invasive carcinoma	491	34.5	65	19.7	426	39.0
DCIS only	280	19.7	95	28.8	185	16.9
Mixed	636	44.7	160	48.5	476	43.6
Missing	16	1.1	10	3.0	6	0.6
Tumor size, mm						
0.0–9.9	316	22.2	59	17.9	257	23.5
10.0–19.9	480	33.7	60	18.2	420	38.4
20.0–29.9	160	11.2	16	4.9	144	13.2
30.0–39.9	39	2.7	7	2.1	32	2.9
40.0–49.9	15	1.1	6	1.8	9	0.8
50.0	75	5.3	67	20.3	8	0.7
Missing	338	23.8	115	34.9	223	20.4
Tumor grade						
Grade 1	373	26.2	83	25.2	290	9.9
Grade 2	604	42.5	122	37.0	482	26.5
Grade 3	286	20.1	73	22.1	213	44.1
Missing	160	11.2	52	15.8	108	19.5
Orientation of margin distances reported						
Radial	102	7.2	24	7.3	78	7.1
Anterior	56	3.9	12	3.6	44	4.0
Posterior	64	4.5	9	2.7	55	5.0
Multiple	750	52.7	137	41.5	613	56.1
None Reported	451	31.7	148	44.9	303	27.7

Abbreviations: DCIS, ductal carcinoma in situ

Table 3

Crude frequency of re-excision and/or mastectomy after breast conserving surgery according to compliance with CAP guidelines for margin reporting.

	All cases	Re-excision or Mastectomy*	Re-excision	Mastectomy
	N (%)	No. (%)	No. (%)	No. (%)
Non-Compliant	307 (22)	90 (29)	50 (16)	43 (14)
Minimally Compliant	487 (34)	128 (26)	103 (21)	35 (7)
Maximally Compliant	629 (44)	112 (18)	93 (15)	26 (4)
Trend test p value		<0.001	0.25	<0.001

* Note that the counts included in the separate columns for re-excision and mastectomy are not mutually exclusive, and thus do not sum up to the count of women undergoing re-excision or mastectomy. Some women had re-excision followed by mastectomy.

Association between compliance to CAP guidelines for margin reporting and frequency of re-excision and/or mastectomy after breast conserving surgery.

Table 4

	Unadjusted			Multivariable adjusted*		
	Odds Ratio	95% CI	P-Value	Odds Ratio	95% CI	P-Value
<u>Re-excision or mastectomy</u>						
Maximally compliant	1	Ref	Ref	1	Ref	Ref
Minimally compliant	1.65	1.24, 2.19	<0.001	1.59	1.05, 2.24	0.03
Non-compliant	1.91	1.39, 2.64	<0.001	1.69	1.15, 2.48	0.01
<u>Re-excision</u>						
Maximally compliant	1	Ref	Ref	1	Ref	Ref
Minimally compliant	1.55	1.13, 2.11	0.006	1.59	1.06, 2.38	0.03
Non-compliant	1.12	0.77, 1.63	0.55	1.02	0.66, 1.58	0.92
<u>Mastectomy</u>						
Maximally compliant	1	Ref	Ref	1	Ref	Ref
Minimally compliant	1.8	1.07, 3.03	0.03	1.38	0.87, 2.19	0.17
Non-compliant	3.78	2.27, 6.28	<0.001	2.50	1.64, 3.80	<0.001

* Adjusted for age, procedure year, cancer type, grade, tumor size, and clustering by provider facility.