Ann Surg Oncol (2023) 30:4695–4713
https://doi.org/10.1245/s10434-023-13472-w

Annals of
SURGICAL ONCOLOGY
OFFICIAL JOURNAL OF THE SOCIETY OF SURGICAL ONCOLOGY

REVIEW ARTICLE – BREAST ONCOLOGY

Surgeon Factors Influencing Breast Surgery Outcomes: A Scoping Review to Define the Modern Breast Surgical Oncologist

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ABSTRACT

Background. Modern breast surgical oncology incorporates many aspects of care including preoperative workup, surgical management, and multidisciplinary collaboration to achieve favorable oncologic outcomes and high patient satisfaction. However, there is variability in surgical practice and outcomes. This review aims to identify modifiable surgeon factors influencing breast surgery outcomes and provide a definition of the modern breast surgical oncologist.

Methods. A systematic literature search with additional backward citation searching was conducted. Studies describing modifiable surgeon factors with associated breast surgery outcomes such as rates of breast conservation, sentinel node biopsy, re-excision, complications, acceptable esthetic outcome, and disease-free and overall survival were included. Surgeon factors were categorized for qualitative analysis.

Results. A total of 91 studies met inclusion criteria describing both modifiable surgeon factor and outcome data. Four key surgeon factors associated with improved breast surgery outcomes were identified: surgical volume (45 studies), use of oncoplastic techniques (41 studies), sub-specialization in breast surgery or surgical oncology (9 studies), and participation in professional development activities (5 studies).

Conclusions. On the basis of the literature review, the modern breast surgical oncologist has a moderate- to high-volume breast surgery practice, understands the use and application of oncoplastic breast surgery, engages in additional training opportunities, maintains memberships in relevant societies, and remains up to date on key literature. Surgeons practicing in breast surgical oncology can target these modifiable factors for professional development and quality improvement.

First Received: 30 January 2023
Accepted: 26 March 2023
Published online: 10 April 2023

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Surgical management of breast cancer has evolved dramatically over recent decades.[1–4] Surgical interventions have been de-escalated with techniques such as breast conserving surgery (BCS), oncoplastic breast surgery (OPBS), and sentinel lymph node biopsy (SLNB).[2,3] These developments in surgical care have been matched with improved neoadjuvant and adjuvant therapies.[2,3] Taken together, these advancements have led to improved oncologic and esthetic outcomes for patients, with decreased morbidity.[2]

Professional societies and regulatory bodies from across the world have published quality indicators for breast surgery and minimum quality standards for breast centers.[5–11] Quality indicators include preoperative workup of breast cancers, discussion of cases at multidisciplinary tumor boards, and adherence to guidelines.[5] Indicators specific to surgical care for breast cancer include breast conservation rates, re-excision rates, and referral for immediate reconstruction in eligible patients.[5] The heterogeneity in quality indicators across geographic regions, together with the variability in breast surgical oncology practice, highlight a lack of consensus in the definition of high-quality care in breast surgery.[5]

The modern breast surgeon must balance appropriate management of the underlying pathology with functional and esthetic outcomes. Many surgeon factors influencing breast surgery outcomes have been described with the goal of standardizing the quality of care in breast surgery. Surgeon practice volume has been linked to improved outcomes and may be associated with achievement of quality

care indicators.[12–18] Sub-specialization in surgical oncology or oncoplastic breast surgery has also been associated with improved outcomes.[19–21] Furthermore, the use of oncoplastic techniques has been shown to provide similar oncologic outcomes to standard breast conserving surgery, while extending eligibility for breast conservation and improving cosmetic outcomes.[22,23] This study aims to define the characteristics of a high-quality modern-day breast surgeon through a systematic examination of the existing literature describing modifiable surgeon factors influencing breast surgery outcomes.

METHODS

Literature Search and Study Selection

This scoping review was conducted according to PRISMA-ScR guidelines.[24] A comprehensive search encompassing five databases [OVID Medline, OVID EMBASE, Cochrane Library (CDSR and Central), PROSPERO, and SCOPUS] was conducted. Search terms included "surgeons", "surgeon characteristics", "breast cancer", "outcomes". Searches were limited to 1 January 2000–8 November 2021 to capture modern breast surgery practices (Appendix 1). After duplicates were removed, the search identified 2315 results (Appendix 1). Two independent reviewers screened 2315 titles and abstracts (JFR, ANR) through COVIDENCE software (Veritas Health Innovation, Melbourne Australia) and disagreements were resolved by consensus. Full text review was completed for 149 abstracts and 54 studies met inclusion criteria for the final analysis. Backward citation searching was conducted for each article, identifying 127 articles with 37 meeting inclusion criteria (Fig. 1).

Inclusion and Exclusion Criteria

Articles describing at least one modifiable surgeon factor influencing breast surgery outcomes were included. Only full-length articles published in English were included. Additionally, studies describing institutional factors but not modifiable surgeon factors were excluded. Articles published prior to the year 2000 or those describing patient cohorts treated exclusively prior to the year 2000 were excluded.

Data Extraction and Qualitative Analysis

Outcome measures included: oncologic, esthetic, and patient-reported outcomes, as well as surgical complications. All extracted outcome data are represented according to the

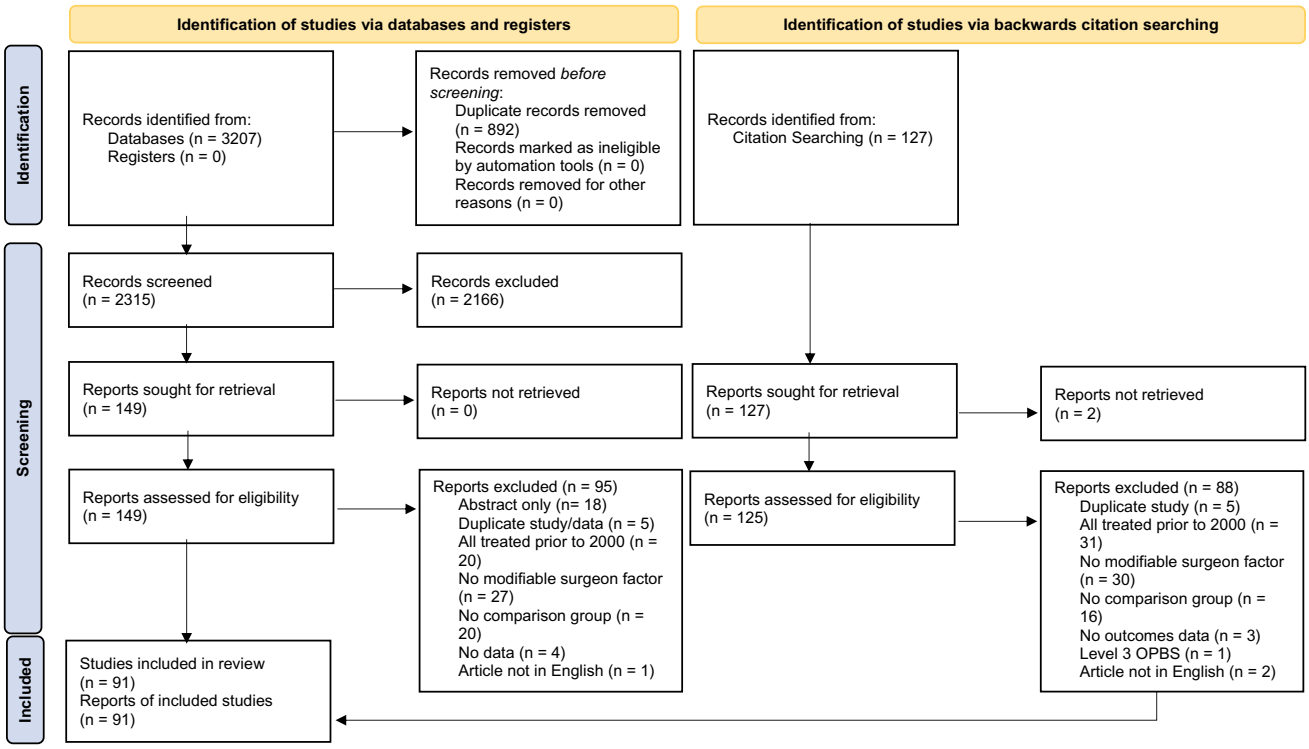

FIG. 1 PRSIMA flow diagram for study screening and inclusion; *Source*: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. https://doi.org/10.1136/bmj.n71

primary statistical analyses reported in the original study. Only statistically significant findings are presented, unless otherwise described as a "trend" or as "no difference." No additional statistical analyses on previously published data were completed for this scoping review.

Extracted data were qualitatively analyzed, summarized, and organized by surgeon factor. Surgeon factors were grouped into four themes; surgeon volume, use of oncoplastic techniques, fellowship or subspecialty training in surgical oncology or breast surgery, and participation in professional development or quality improvement activities. Non-modifiable surgeon factors such as surgeon age, gender, and years in practice were not recorded.

RESULTS

Study Characteristics

A total of 91 studies met inclusion criteria. A variety of study designs were represented, including surveys (21 studies), retrospective (56 studies) and prospective cohorts (13 studies), reviews or meta-analyses (3 studies), retrospective case control (4 studies), and randomized controlled trials (1 study). Six studies utilized more than one methodology (for example, survey and retrospective cohort). Studies included patients and surgeons from North America, Europe, Asia, and South America, with 18 countries represented.

Surgeon factors were categorized into four themes: surgeon volume (45 studies), use of oncoplastic techniques/oncoplastic training (41 studies), fellowship or subspecialty training in surgical oncology or breast surgery (9 studies), and participation in professional development and quality improvement activities (5 studies) (Fig. 2). Nine studies investigated more than one surgeon factor; in these cases, the data were reported individually. Surgeon factors and associated outcome measures are summarized in Tables 1, 2, 3 and 4.

Surgeon Volume and Proportion of Practice in Breast Surgery

A total of 45 studies identified surgeon volume as key a factor impacting outcomes in breast surgery (Table 1). This was reported as either an interval volume or as a proportion of the surgeon's practice dedicated to breast surgical oncology. Among these studies, there was no standardized definition of a high-volume surgeon.

Seventeen studies examined surgical techniques in relation to surgical volume. Higher surgical volume was associated with increased use of BCS[16,25–31] and deceased completion mastectomy rates.[32,33] Furthermore, high-volume surgeons were less likely to routinely use or report use of axillary lymph node dissection (ALND)[34,35] and were more likely to use or report use of SLNB,[36–38] with decreased rates of SLNB failure.[39] High-volume surgeons were also less likely to evaluate the axilla surgically in DCIS cases.[40] Finally, patients of high-volume surgeons were more likely to be successful in same-day discharge and home recovery and demonstrated decreased incidence of surgical site infections.[41,42]

Regarding local control of disease, higher-volume surgeons were less likely to obtain positive margins in one study,[15] had lower re-excision rates in seven studies,[13,14,20,33,43–45] and exhibited a trend toward lower re-excision rates for pathologically negative margins in one study.[46] High-volume surgeons were also more likely to employ techniques to reduce re-excision rates such as cavity shave margins.[15] Finally, one study noted decreased

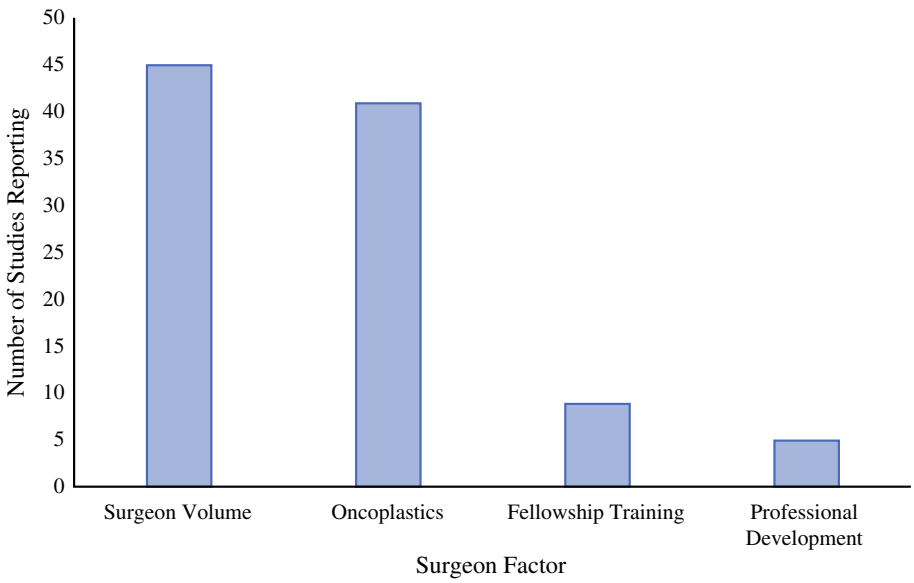

FIG. 2 Number of studies reporting surgeon factors by category

TABLE 1 Outcomes associated with surgeon volume and proportion of breast surgery practice

Study lead author	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Baliski[43]	2021	*Ann Surg Oncol*	Retrospective cohort	522 patients	High surgeon volume	Decreased re-ex rates for very high-volume surgeons versus intermediate volume (OR 0.44).
Vuong[41]	2021	*J Am Coll Surg*	Retrospective cohort (DB)	2648 patients	High surgeon volume	Increased rates of successful home recovery (OR 2.12).
Salindera[12]	2020	*Breast*	Retrospective cohort (DB)	35,459 patients 361 surgeons	High surgeon volume	Increased compliance with some quality indicators.
Crown[89]	2019	*Am J Surg*	Retrospective Cohort (DB)	561 patients	High surgeon volume	Decreased surgical site complications (15.8% versus 32.6%).
Kaczmarski[44]	2019	*J Am Coll Surg*	Retrospective cohort	291,065 patients 5337 surgeons	High surgeon volume	Decreased re-ex rates (OR 0.78-0.92).
Landercasper[45]	2019	*Ann Surg Oncol*	Prospective cohort (DB)	3954 patients 71 surgeons	High surgeon volume	Decreased re-ex rates (OR 0.68).
Taban[17]	2019	*Swiss Med Wkly*	Retrospective cohort (Reg)	1489 patients 88 surgeons	High surgeon volume	Decreased breast cancer mortality (HR 0.45). Increased compliance with some quality indicators and overall quality of care (87.7% versus 82.6%).
Gu[25]	2018	*Clin Breast Cancer*	Systematic review	87,067 patients	High surgeon volume	Increased use of BCS for surgeons with volume > 10 annual cases.
Katz[114]	2018	*JAMA Surg*	Survey	3910 patients370 surgeons	Low surgeon volume	Decreased use of genetic testing (OR 0.41-0.45).
Morrow[35]	2018	*JAMA Oncol*	Survey	376 surgeons	Higher surgeon volume	Decreased reported propensity for ALND.
Yen[34]	2018	*Med Care*	Retrospective cohort (DB)	7686 patients 1759 surgeons	High surgeon volume	Decreased use of ALND in pathologically node-negative patients (OR 0.59).
Morrow[54]	2017	*JAMA Oncol*	Survey	3729 patients 342 surgeons	High surgeon volume	More likely to accept no ink on tumor as adequate margin for invasive breast cancer after SSO-ASCO guideline.
Schulman[115]	2017	*Ann Surg Oncol*	Retrospective cohort (DB)	26,102 patients 252 surgeons	High proportion breast practice	Decreased overall re-ex rates post-guideline publication. No surgeon factor associated with decrease in re-ex for close margins.
Hughes[13]	2016	*Ann Surg Onc*	Retrospective cohort	581 patients	High surgeon volume	Decreased re-ex rates (OR 0.42).
Isaacs[14]	2016	*JAMA Surg*	Retrospective cohort (DB)	89,448 patients	Low surgeon volume	Increased re-ex rates (OR 1.49).

Table 1 (continued)

Study lead author	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Coromilas[40]	2015	*JAMA Oncol*	Retrospective cohort (DB)	35,591 patients	High surgeon volume	Decreased use of axillary evaluation in BCS for DCIS (RR 0.54).
Pezzin[47]	2015	*Med Care*	Survey	2408 patients	High surgeon volume	No difference in all-cause or breast-cancer-specific mortality.
Tamirisa[49]	2015	*Ann Surg*	Retrospective cohort (DB)	22,711 patients 1226 surgeons	High surgeon volume	Increased use of preop needle biopsy (OR 2.14).
Eberth[20]	2014	*J Clin Oncol*	Retrospective cohort (DB)	89,712 patients 12,405 surgeons	Low volume surgeon	Decreased use of preop needle biopsy (RR 1.66). Increased re-ex rates (RR 1.08).
Landercasper[98]	2014	*Ann Surg Oncol*	Retrospective cohort (DB)	6725 patients 328 surgeons	High proportion breast practice	No difference in re-ex rates.
Yen[36]	2014	*JAMA Surg*	Survey + retrospective cohort	1703 patients 863 surgeons	High surgeon volume + proportion breast practice	Increased use of initial SLNB for surgeons with higher volume and percentage of breast surgery practice.
De Camargo Cancela[32]	2013	*Breast Cancer Res Treat*	Retrospective cohort (Reg)	8318 patients	Low surgeon volume	Increased completion mastectomy rate (IRR 1.17).
McDermott[16]	2013	*Ann Surg*	Retrospective cohort (DB)	79,885 patients 472 surgeons	Surgeon volume	Low surgeon volume associated with increased mastectomy rates (OR 1.19). BCS for tumors > 2 cm more likely with high-volume surgeon. Medium-volume surgeons more likely to perform SLNB (OR 1.36) than high-volume surgeons.
Roder[26]	2013	*Asian Pac J Cancer Prev*	Retrospective cohort	30,299 patients	Low surgeon volume	Increased mastectomy rates (RR 1.08).
Hershman[51]	2012	*Breast Cancer Res Treat*	Retrospective cohort (DB)	123,702 patients	High surgeon volume	Increased use of immediate reconstruction in patients with invasive cancer (OR 1.19) and DCIS (OR 1.15).
Lovrics[50]	2012	*Breast*	Survey	302 surgeons	High surgeon volume	Increased use of preop biopsy and intraoperative pathologist gross margin inspection. Decreased use of excisional biopsy.
McCahill[46]	2012	*JAMA*	Retrospective cohort (DB)	2206 patients 2220 cancers	High surgeon volume	Trend toward decreased re-ex of pathologically negative margins. High inter-surgeon variability for re-ex rates.

Table 1 (continued)

Study lead author	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Peltoniemi[27]	2012	*Breast*	Retrospective cohort (Reg)	1377 patients	High surgeon volume	Increased use of BCS by high- (OR 1.32, NS) and intermediate- (OR 1.54, NS) volume surgeons for invasive cancer. No differences for DCIS. No difference in LR.
Scher[55]	2011	*J Oncol Pract*	Survey	171 surgeons	High surgeon volume	Trend toward increased probability of weekly MDTB attendance (NS).
Clifford[18]	2010	*Ann Surg Oncol*	Retrospective cohort (DB)	28,798 patients 696 surgeons	High proportion breast practice	Increased compliance with some quality indicators.
Lovrics[15]	2010	*Can J Surg*	Retrospective cohort	489 patients	High surgeon volume	Increased use of preop needle biopsy (84.2% versus 60.0%), and cavity shave margins (57.0% versus 33.5%). Decreased margin positivity (16.4% versus 29.1%) and re-ex (17.0% versus 29.7%) rates. No differences in specimen orientation and radiograph.
Hershman[28]	2009	*Ann Surg*	Retrospective cohort (DB)	56,768 patients 6224 surgeons	High surgeon volume	Increased use of BCS in elderly patients (OR 1.29).
Hershman[48]	2008	*J Natl Cancer Inst*	Retrospective cohort (DB)	29,760 patients 4455 surgeons	High surgeon volume	Improved radiation therapy completion in elderly patients (OR 1.18).
Quan[37]	2008	*Breast J*	Survey	503 surgeons	High proportion breast practice	Increased reported use of SLNB (OR 7.0).
Alderman[116]	2007	*Cancer*	Survey	365 surgeons	High surgeon volume	More likely to refer to plastic surgery for reconstruction (OR 4.08).
Burkholder[33]	2007	*Am Surg*	Retrospective cohort	489 wire localizations 14 surgeons	High surgeon volume	Decreased re-ex (18.7% versus 11.0%) and completion mastectomy (28.0% versus 59.1%) rates.
Chagpar[117]	2007	*Breast J*	Prospective cohort	4131 patients	High surgeon volume	No difference in ALND adequacy defined as $\geq$ 10 lymph nodes in specimen.
					High proportion breast practice	Decreased rate of adequate ALND (OR 0.46).

Table 1 (continued)

Study lead author	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Hawley[52]	2007	*Patient Educ Couns*	Survey	1101 patients 277 surgeons	High surgeon volume	Patient reported too little involvement in decision-making (OR 1.68).
Waljee[53]	2007	*J Clin Oncol*	Survey	1539 patients 318 surgeons	High proportion breast practice	Increased patient satisfaction in decision-making process (OR 1.79) and with surgeon–patient relationship (OR 1.98).
Chagpar[29]	2006	*Cancer*	Prospective cohort	4086 patients	High proportion breast practice	Increased use of BCS (70.8% versus 63.7%, NS on multivariate analysis).
Hawley[118]	2006	*Med Care*	Survey	1477 patients 311 surgeons	Surgeon volume	Surgeon volume associated with variation in BCS rates and post-mastectomy reconstruction rates.
Katz[30]	2005	*Cancer*	Survey	365 surgeons	High surgeon volume	Preference for BCS + radiation therapy in invasive breast cancer (87.2% versus 60.8%).
Najafi[31]	2005	*BMC Cancer*	Survey	83 surgeons	High surgeon volume	Increased routine use of BCS.
Posther[39]	2005	*Ann Surg*	Prospective cohort (RCT subset)	5327 patients 198 surgeons	Low surgeon volume	Increased rate of SLNB failure (2.0% versus 0.7%).
Porter[38]	2003	*Ann Surg Oncol*	Survey	519 surgeons	High proportion breast practice	Increased reported use of SLNB (OR 15.2).

ALND axillary lymph node dissection, *BCS* breast conserving surgery, *DB* database, *DCIS* ductal carcinoma in situ, *HR* hazard ratio, *IRR* incidence rate ratio, *LR* local recurrence, *MDTB* multidisciplinary tumor board, *NS* not significant, OR odd ratio, Preop preoperative, *RCT* randomized controlled trial, *Re-ex* re-excision, *Reg* registry, *RR* relative risk, *SLNB* sentinel lymph node biopsy

TABLE 2 Outcomes associated with the use of oncoplastic breast surgery techniques

Study	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Angarita[90]	2020	*Breast Cancer Res Treat*	Retrospective cohort (DB)	109,487 patients	OPBS versus BCS	Increased early postop morbidity (3.8% versus 2.6%; OR 1.41). No difference in mortality.
de Oliveira-Junior[87]	2020	*Clin Breast Cancer*	Prospective cohort	300 patients	OPBS versus BCS	No difference in cosmetic outcomes.
Behluli[62]	2019	*ANZ J Surg*	Retrospective cohort	343 patients	OPBS versus BCS	Decreased re-ex (7.7% versus 34.4%) and completion mastectomy (0% versus 11.3%) rates. No difference in complications.
Crown[89]	2019	*Am J Surg*	Retrospective cohort (DB)	561 patients	OPBS versus BCS	Decreased surgical site complications (OR 0.28). No difference in postop interventions.
Dogru[67]	2019	*Breast Cancer*	Prospective RCT	80 patients	OPBS versus BCS	Higher patient self-reported cosmetic scores. No difference in margin positivity or complication rates.
Jonczyk[91]	2019	*Cancers*	Retrospective cohort (DB)	226 899 patients	OPBS versus M+R	Decreased overall (3.20% versus 5.68–13.04%) and bleeding complications (OR 2.78 versus OR 3.61–10.99).
					OPBS versus BCS	Increased overall (3.20% versus 2.25%) and bleeding complications (OR 2.78).
Kelemen[63]	2019	*Eur J Surg Oncol*	Retrospective cohort	700 patients	OPBS versus BCS	Improved cosmetic (4.4 versus 3.2), social functioning (83.4 versus 75.0), and body image (91.6 versus 75.0) scores. Longer operating time (68 min versus 58 min). Decreased re-ex (8.0% versus 16.6%) and completion mastectomy (2.6% versus 5.7%) rates. No difference in complications, LR, or time to adjuvant therapy.
Landercasper[45]	2019	*Ann Surg Oncol*	Prospective cohort (DB)	3954 patients 71 surgeons	OPBS	Trend toward decreased re-ex rates (OR 0.76, NS).

Table 2 (continued)

Study	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Bali[68]	2018	*Clin Breast Cancer*	Retrospective cohort (DB)	201 patients	OPBS versus BCS	Increased LOS (1.3 versus 0.2 days). Trend toward decreased margin positivity (15.7% versus 5.7%) and completion mastectomy (0% versus 5.4%) rates, but NS. No difference in re-ex rates.
Mukhtar[56]	2018	*Ann Surg Oncol*	Retrospective cohort (DB)	358 patients 365 tumors	OPBS versus BCS	Decreased margin positivity rates (Level 1 OPBS OR 0.17; Level 2 OPBS OR 0.15 – NS).
Broecker[69]	2017	*Ann Plast Surg*	Survey + retrospective cohort	87 patients	OPBS versus BCS	Increased cosmetic satisfaction. No difference in margin positivity, re-ex, completion mastectomy, LR, and mortality.
Campbell[119]	2017	*Breast Cancer*	Systematic review	Not applicable	OPBS versus BCS	No difference or improved re-ex and LR rates.
Chand[82]	2017	*Plast Reconstr Surg Glob Open*	Survey	150 patients	OPBS versus LD Miniflap	Improved patient-reported cosmetic satisfaction. No difference in reported function.
Kelsall[84]	2017	*J Plas Recontsr Aesthet Surg*	Retrospective case control (DB)	567 patients	OPBS versus M + R	Improved body image and cosmesis scores and faster return to full activity (15.4 versus 19.6 weeks) for larger breast patients. Faster return to work (10.2 versus 13.5 weeks) for patients with smaller breasts.
Ojala[76]	2017	*Eur J Surg Oncol*	Survey + retrospective cohort (DB)	379 patients	OPBS versus BCS	Decreased patient-reported good cosmetic outcome (61% versus 81%). No difference in re-ex or complication rates.
Wijgman[70]	2017	*Eur J Surg Oncol*	Retrospective cohort (Reg)	828 patients 842 tumors	OPBS versus BCS	No difference in margin positivity, re-ex, and complication rates.
Mansell[71]	2017	*Breast*	Retrospective cohort (DB)	980 patients	OPBS versus BCS	Increased completion mastectomy (12.5% versus 5.4%) and distant recurrence rates (7.5% versus 3.3%), but higher proportion of node-positive disease and larger tumors. No difference in margin positivity, LR, DFS, OS.

Table 2 (continued)

Study	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
					OPBS versus M+R	Decreased distant recurrence (7.5% versus 13.1%). Improved DFS (90.7% versus 85.6%) and OS (98.1% versus 84.6%).
Carter[79]	2016	*Ann Surg Oncol*	Retrospective cohort (DB)	9861 patients 10,607 operations	OPBS versus BCS	Increased wound complications (4.8% versus 1.4%). No difference in recurrence or OS.
					OPBS versus M+R	Decreased wound complications (4.8% versus 11.6%).
Chauhan[57]	2016	*Indian J Surg Oncol*	Prospective + retrospective cohort	100 patients	OPBS versus BCS	Decreased margin positivity rate. No difference in re-ex or complication rates.
Chauhan[58]	2016	*Med J Armed Forces India*	Prospective + retrospective cohort	79 patients	OPBS versus BCS	Decreased margin positivity and re-ex rates. No difference in complication rates.
Cil[88]	2016	*Ann Surg Oncol*	Retrospective cohort (DB)	75,972 patients	OPBS versus BCS	No difference in complication rates.
De Lorenzi[72]	2016	*Eur J Surg Oncol*	Retrospective case control (DB)	1362 patients	OPBS versus BCS	No difference in margin positivity rates, DFS, or OS.
De Lorenzi[81]	2016	*Ann Surg Oncol*	Retrospective case control (DB)	579 patients	OPBS versus mastectomy	No difference in DFS and OS.
Tong[92]	2016	*Plast Reconstr Surg*	Retrospective cohort (DB)	408 patients	OPBS versus M+R	Decreased LOS (1.4 versus 3.8 days), complications delaying adjuvant therapy (0.8% versus 14.4%), major complications (OR 0.10), and repeat surgery for complications (2.3% versus 27.1%) in obese patients. No difference in overall complication rate.
Vieira[73]	2016	*Ann Med Surg*	Retrospective case control	78 patients	OPBS versus BCS	No difference in margin positivity, LR, DFS, and OS.
Crown[42]	2015	*Ann Surg Oncol*	Retrospective cohort	812 patients	Oncoplastic Training	Decreased re-ex (18% versus 32%) and index mastectomy rates (15% versus 34%).
Mansell[74]	2015	*Breast*	Retrospective cohort (DB)	1000 patients	OPBS versus BCS	Increased completion mastectomy rates (11.8% versus 5.5%). No difference in margin positivity rates.

Table 2 (continued)

Study	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Santos[85]	2015	*Ann Surg Oncol*	Retrospective cohort	122 patients	OPBS versus BCS	Improved "excellent" cosmetic outcomes with software (22.8% versus 6.2%) and specialist (50.9% versus 18.5%) evaluation. No difference on patient evaluation.
Acosta-Marin[86]	2014	*Ecacncer medicalscience*	Prospective cohort	107 patients	OPBS versus BCS	Improved surgeon and patient reported cosmetic satisfaction scores at 12 months.
Losken[59]	2014	*Ann Plast Surg*	Meta-Analysis	8659 patients	OPBS versus BCS	Improved cosmetic satisfaction (89.5% versus 82.9%). Decreased complications (15.5% versus 25.9%), and margin positivity (12.3% versus 20.6%), re-ex (4.0% versus 14.6%). Increased completion mastectomy (6.5% versus 3.8%).
Losken[60]	2014	*Aesthet Surg J*	Retrospective cohort	207 patients 222 surgeries	OPBS versus BCS	Decreased margin positivity (OR 0.47), re-ex (OR 0.41), and completion mastectomy rates (OR 0.24 – NS).
Tenofsky[77]	2014	*Am J Surg*	Retrospective cohort	140 patients 142 surgeries	OPBS versus BCS	No difference in re-ex rates, time to radiation therapy, number of postop biopsies, and cosmesis.
Down[64]	2013	*Breast J*	Retrospective cohort	157 patients	OPBS versus BCS	Decreased re-ex rates (5.4% versus 28.9%). No difference in wound infection or LR.
Gulcelik[65]	2013	*J Breast Cancer*	Prospective cohort	268 patients	OPBS versus BCS	Decreased re-ex rates (10.3% versus 15.0%). No difference in LR or OS.
Khan[80]	2013	*Eur J Surg Oncol*	Retrospective cohort (DB)	169 patients	OPBS versus BCS	No difference in time to adjuvant chemotherapy.
Mazouni[78]	2013	*Breast*	Retrospective cohort	259 patients	OPBS versus BCS	Increased repeat surgery for complications (2% versus 1%). No difference in re-ex, completion mastectomy, LR, OS, or cosmetic scores.
Chakravorty[66]	2012	*Eur J Surg Oncol*	Retrospective cohort	586 patients	OPBS versus BCS	Decreased re-ex rate (6.6% versus 14.5%). No difference in LR or OS.

Table 2 (continued)

Study	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Veiga[83]	2011	*Breast*	Prospective + retrospective cohort	90 patients	OPBS versus BCS	Better cosmetic outcomes as rated by patients and surgeons at 12 months.
Losken[120]	2009	*Plast Reconstr Surg*	Retrospective cohort	34 patients	OPBS versus BCS	Increased number of postop biopsies (0.25 versus 0.03 per follow-up year). No difference in time to postop mammographic stability or number of imaging studies.
Giacalone[75]	2007	*Ann Surg Oncol*	Prospective cohort	74 patients	OPBS versus BCS	Increased average operating time. No difference in postop LOS or margin positivity at 2 mm.
Kaur[61]	2005	*Ann Surg Oncol*	Prospective cohort	60 patients	OPBS versus BCS	Increased rate of negative margin at 2 mm (83.4% versus 56.7%).

BCS breast conserving surgery, *DB* database, *DFS* disease-free survival, *LD* latissimus dorsi, *LOS* length of stay, *LR* local recurrence, *M + R* mastectomy with reconstruction, *NS* not significant, *OPBS* oncoplastic breast surgery, *OR* odds ratio, *OS* overall survival, *postop* postoperative, *Re-ex* re-excision

breast-cancer-specific mortality for patients of high-volume surgeons, while another did not identify any differences.[17,47]

With respect to other quality indicators, high surgical volume has also been demonstrated to be associated with increased completion of radiation therapy after BCS.[12,17,18,48] Higher-volume surgeons were also more likely to utilize preoperative needle biopsy for diagnosis[15,20,49,50] and intraoperative gross margin assessment by a pathologist.[50] Patients of high-volume surgeons were more likely to undergo immediate reconstruction after mastectomy.[51] There was disagreement between studies regarding patient satisfaction with involvement in decision-making;[52,53] however, patients described increased satisfaction with the surgeon–patient relationship with a high-volume surgeon.[53] Finally, surgeons with a higher practice volume were more likely to agree with published margin guidelines for invasive breast cancer[54] and trended toward increased rates of attendance at multidisciplinary tumor boards.[55]

Use of Oncoplastic Techniques

The use of oncoplastic techniques is a modifiable surgeon factor that has been evaluated in 41 studies (Table 2). In the studies included in this review, the specific oncoplastic techniques were variable between studies. Level I (≤ 20% volume excision without skin excision)[2] and level II (20–50% volume excision with skin excision or mammoplasty)[2] oncoplastic techniques were most commonly described. A minority of studies included a small percentage of volume replacement techniques (such as latissimus dorsi miniflaps) in their data analyses. The use of oncoplastic techniques was described in comparison to standard BCS and mastectomy with reconstruction.

A total of 23 studies reported on the oncologic outcomes associated with OPBS. Regarding local control of disease, OPBS was associated with decreased margin positivity rates in six studies[56–61] and decreased re-excision rates in eight studies.[58–60,62–66] Other studies have described OPBS to be equivalent to standard BCS with regards to margin positivity,[67–75] re-excision rates,[45,57,68–70,76–78] and local recurrence.[63–66,69,71,78,79] Three studies demonstrated decreased completion mastectomy rates in patients undergoing OPBS,[60,62,63] while two studies reported equivalent rates.[68,78] Two additional studies reported increased rates of completion mastectomy after OPBS.[59,74] Time to adjuvant therapy,[63,77,80] disease-free survival,[71–73,81] and overall survival and mortality[65,66,69,71–73,78,79,81] were equivalent between OPBS and BCS.

Nine studies noted improved esthetic outcomes with OPBS by patient-reported metrics and/or surgeon evaluation.[59,63,67,69,82–86] Three studies reported no differences in cosmetic outcomes between OPBS and standard BCS.[77,78,87] Only one study reported worse cosmetic

TABLE 3 Outcomes associated with surgical oncology or breast surgery specialization

Study first author	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Smith[21]	2020	*Ann Surg Oncol*	Survey	289 patients 271 surgeons	Surg oncol training	Increased cosmetic satisfaction and physical well-being scores.
DeSnyder[93]	2018	*Ann Surg Oncol*	Survey	767 surgeons	Breast surgeon specialization	Increased reported DCIS margin guideline familiarity (96.9% versus 87.0%). Less likely to re-ex for 2 mm margin in DCIS (91.7% versus 80.9%).
Tamirisa[49]	2015	*Ann Surg*	Retrospective cohort (DB)	22,711 patients 1226 surgeons	Surg oncol Training	No difference in use of preop needle biopsy.
Eberth[20]	2014	*J Clin Oncol*	Retrospective cohort (DB)	89,712 patients 12,405 surgeons	General surgeon	Decreased use of preop needle biopsy (RR 1.11). Increased re-ex rates (RR 1.14).
Shaterian[94]	2013	*World J Surg*	Retrospective cohort	344 patients	Dual-trained surgeon	Increased mastectomy reconstruction rate (71.1% versus 63.3%).
Dooley[19]	2011	*Ann Surg Oncol*	Retrospective cohort (Reg)	2192 patients	Surg oncol training	Increased use of BCS (52.6% versus 38.3%), RT completion for BCS (97.3% versus 67.0%), completion of adjuvant systemic therapy (77.3% versus 68.5%), axillary RT for ≥ 4 positive nodes (98.6% versus 72.4%), and patient participation in clinical trials (56.2% versus 7.0%). Improved DFS (80.7% versus 72.0%) and OS (83.8% versus 75.6%) for stages 1–3.
Quan[37]	2008	*Breast J*	Survey	503 surgeons	Surg oncol or breast training	Increased reported use of SLNB (OR 5.58).
Zork[95]	2008	*Ann Surg*	Retrospective cohort	596 patients	Breast surgeon specialization	Increased use of BCS for stage I/II disease (69.4% versus 58.0%), SLNB (90% versus 35%), preop needle biopsy (92.8% versus 87.8%). Decreased margin positivity (6.7% versus 16.5%) rates. No difference in BCS rates for DCIS or mastectomy reconstruction.
Porter[38]	2003	*Ann Surg Oncol*	Survey	519 surgeons	Surg oncol training	Increased reported use of SLNB (OR 4.8).

BCS breast conserving surgery, *DCIS* ductal carcinoma in situ, *DFS* disease-free survival, *OR* odds ratio, *OS* overall survival, *Preop* preoperative, *Reg* registry, *RR* relative risk, *RT* radiation therapy, *SLNB* sentinel lymph node biopsy, *Surg oncol* surgical oncology

TABLE 4 Outcomes associated with participation in professional development activities

Study first author	Year	Journal	Study design	Participants	Summary of key findings	
					Surgeon factor	Associated outcomes
Morrow[35]	2018	*JAMA Oncol*	Survey	376 surgeons	Case discussion at MDTB	Decreased reported propensity for ALND.
Caudle[96]	2017	*Ann Surg Oncol*	Survey	642 surgeons	Knowledge of key trials	Increased self-reported use of SLNB post-neoadjuvant chemotherapy (87.4% versus 69.2%).
Landercasper[98]	2014	*Ann Surg Oncol*	Retrospective cohort (DB)	6725 patients 328 surgeons	Participation in QI program	Decreased re-ex rates. Surgeons not participating in QI program had higher re-excision rates (OR 1.24).
Yen[36]	2014	*JAMA Surg*	Survey + retrospective cohort	1703 patients 863 surgeons	ASBrS member	Increased use of initial SLNB (OR 1.98).
					SSO member	Increased use of initial SLNB (OR 1.59).
					Dual member	Increased use of initial SLNB (OR 3.14).
Meyer[97]	2013	*Med Care*	Retrospective cohort (DB)	17,177 patients	Community clinical oncology program	Increased use of SLNB during early adoption period (OR 2.68).

ALND axillary lymph node dissection, *ASBrS* American Society of Breast Surgeons, *DB* database, *MDTB* multidisciplinary tumor board, *OR* odds ratio, *QI* quality improvement, *Re-ex* re-excision, *SLNB* sentinel lymph node biopsy, *SSO* Society of Surgical Oncology

outcomes with OPBS.[76] In this study, tumor size and specimen resection weights were significantly larger in the OPBS group.[76] In two out of three articles investigating patient-reported functional outcomes,[63,82,84] OPBS patients had improved postoperative social functioning[63] and faster return to activities.[84]

Regarding early postoperative complications, 11 studies demonstrated equivalent[57,58,62–64,67,70,76,88] or decreased[59,89] complication rates between oncoplastic and standard BCS. In a minority of studies, OPBS was associated with increased early postoperative morbidity such as reoperation,[78] wound complications,[79,90] seromas,[79] bleeding,[90,91] and overall 30-day morbidity[90] compared with BCS. With regard to postoperative length of stay following OPBS, the data were mixed, with one study showing increased length of stay and another showing no difference after OPBS.[68,75]

Five studies commented on OPBS in comparison to mastectomy with reconstruction. OPBS had decreased overall and bleeding complications,[91] decreased wound complications,[79] and improved cosmetic and return to function scores.[84] One study reported decreased rates of distant recurrence and improved disease-free and overall survival.[71] Specifically in obese patients, those undergoing OPBS had fewer complications requiring reoperation or resulting in a delay to adjuvant therapy.[92]

Fellowship or Sub-specialization in Surgical Oncology or Breast Surgery

Nine articles examined outcomes in relation to subspecialty training (Table 3).[19–21,37,38,49,93–95] Patients treated by a surgical oncologist compared with a general surgeon were less likely to undergo re-excision,[20] more likely to have BCS[19] and SLNB,[37,38] and more likely to complete appropriate adjuvant therapy.[19] These patients were more likely to participate in clinical trials, and also had improved disease-free and overall survival for stage 1–3 disease.[19] Notably, one study reported increased use of preoperative diagnostic needle biopsy among surgical oncologists compared with general surgeons for patients treated from 2003 to 2007.[20] In another study, patients of surgical oncologists reported higher cosmetic satisfaction.[21] Finally, specialist breast surgeons were more likely to report familiarity with published guidelines.[93]

Participation in Professional Development and Quality Improvement Activities

Surgeon participation in professional development and quality improvement activities has been demonstrated to improve breast surgery outcomes (Table 4). For example, surgeons who regularly attended multidisciplinary tumor

boards reported decreased propensity for ALND.[35] Similarly, surgeons with knowledge of key trials reported increased use of SLNB.[96] Additionally, being a member of the American Society of Breast Surgeons or Society of Surgical Oncology was associated with increased use of SLNB.[36] If a surgeon was a member of both organizations, the effects on use of SLNB were additive.[36] Participation in a community clinical oncology program linking community and academic surgeons was associated with increased use of SLNB during its early adoption period in the early 2000s.[97] Finally, one study found breast surgeons participating in any type of quality improvement program had decreased re-excision rates after BCS,[98] highlighting the importance of continuing education for the modern-day breast surgeon.

DISCUSSION

Four key surgeon factors associated with improved breast surgery outcomes were identified: surgeon volume, use of oncoplastic techniques, additional training in breast surgery or surgical oncology, and participation in professional development and quality improvement activities. Each of these surgeon factors is modifiable and can be optimized through continuing education and quality improvement initiatives to raise the standard of care in breast surgery.

Internationally, quality indicators are being increasingly measured in breast surgery, and many regions have established minimum targets for achievement.[5–11] Indicators are available for the full continuum of breast cancer care from the initial visit and diagnostic workup, to surgery, adjuvant therapies, and long-term follow-up.[5–11] Quality indicators are variable between regions and there is documented inconsistency in compliance with these standards.[5,12,99,100] As a result, some patients may receive a lower quality of care.

Surgeon-specific quality indicators have been described. Many of these focus on the quality of the preoperative workup.[6,8,10,11] For example, the use of a minimally invasive biopsy for histologic diagnosis of malignancy prior to surgery has been cited as a key quality indicator in many jurisdictions.[6,8,10] Surgeon specialization and higher case volume have both been associated with increased use of minimally invasive biopsy preoperatively.[15,20,49,50,95] Another key quality indicator is the avoidance of surgical overtreatment.[6,8,10,11] All four surgeon factors identified in this review have been associated with the provision of guideline-concordant care and avoidance of overtreatment of disease. Finally, rates of immediate reconstruction after mastectomy have also been noted as an important quality indicator.[6,10,11] Surgeon volume was associated with improved outcomes in this domain.[51] Surgeon-specific quality indicators such as those described above can be targeted for quality improvement through education programs and modification of practice patterns to achieve higher levels of compliance and standards of care.

There are currently many options available to trainees and practicing surgeons to advance their education and training in breast and oncoplastic surgery. These options include short hands-on or online courses,[101–105] meetings held by professional societies, and formal fellowships.[106–109] Breast surgery fellowships are available globally in Canada, the USA, Europe, and Australia and New Zealand.[108] However, the quality of training received at all fellowship programs may not be equal.[108,109] To address this issue, the Society of Surgical Oncology has made efforts to improve the overall standard of education by establishing educational objectives within its accredited programs.[108,109] It should be noted that not all fellowship opportunities include oncoplastic training. Surgeons wishing to include oncoplastic breast surgery in their practice should consider this when pursuing and selecting a fellowship. In addition to formal training, other educational and professional development opportunities exist such as membership in relevant professional societies and participation in multidisciplinary rounds. For surgeons practicing in rural or regional settings, virtual regional multidisciplinary rounds and access to initiatives such as community clinical oncology programs are powerful resources.[97] At this time, there is no clear evidence on how much additional training is required to see an improvement in surgical outcomes. Furthermore, it is not feasible for every surgeon practicing breast surgery to complete a formal fellowship.

While individual surgeon practice factors play an important role, it should be recognized that they are not alone in influencing breast surgery outcomes. Other factors should also be considered in the development and execution of quality improvement measures. It has been well documented in the literature that hospital/institutional factors play a role in outcomes. Similar to surgeon volume, facility volume has also been associated with improved surgical outcomes.[110–112] Additionally, hospital academic affiliation has been described to improve outcomes.[113] Moreover, many regions have strict accreditation criteria for breast centers designed to optimize patient outcomes.[7,9]

In this thorough review of the literature, we have identified four modifiable surgeon factors associated with improved outcomes in breast surgery. From these factors, we have developed a definition of the modern breast surgeon to help guide quality improvement and continuing education initiatives with the goal of raising the overall standard of breast surgical care. On the basis of the examined literature, the modern breast surgeon has a moderate- to high-volume surgical practice, engages in additional training opportunities in breast surgery and oncoplastics, maintains memberships in relevant societies, and remains up to date on key literature. Each component of this definition can be targeted for quality improvement and continuing education.

This review has both strengths and limitations. This study has provided a comprehensive review of the existing literature with a broad search and additional citation searching. Additionally, this review incorporates data originating from a wide geographic distribution providing multiple perspectives on the complex concept of expertise in breast surgery. Finally, the studies and data included were limited temporally to ensure a more modern context. However, there was heterogeneity in the definition of a high- versus low-volume surgeon as well as the definitions of positive and negative margins among the included studies. There was also variation in the OPBS techniques employed in studies. This was likely related to the variations in practice patterns of breast and general surgeons globally. Additionally, use of OPBS techniques was used as a surrogate marker for additional training in oncoplastics for the purpose of this paper. Finally, the breast surgeon's practice also encompasses treatment of benign disease, however, there were no data available in the literature for surgeon factors influencing outcomes in benign breast disease.

Further research to better understand the surgeon factors influencing breast surgery outcomes should include the development of a clear evidence-based definition of high- versus low-volume surgeons. We recommend a large database study be conducted to identify benchmarks for high-, intermediate-, and low-volume surgeons that can be used going forward in future studies. As there were limited data available on the impact of professional development and quality improvement activities, further exploration to determine the best options to be used by surgeons would be beneficial. Finally, studies investigating surgeon factors and outcomes in benign breast disease would be valuable, as most breast surgeons also care for patients with benign disease.

SUPPLEMENTARY INFORMATION The online version contains supplementary material available at https://doi.org/10.1245/s10434-023-13472-w.

FUNDING This study did not receive any dedicated funding.

DISCLOSURE The authors have no conflicts of interest to declare.

REFERENCES

1. Sakorafas GH, Safioleas M. Breast cancer surgery: an historical narrative. Part III. From the sunset of the 19th to the dawn of the 21st century. *Eur J Cancer Care (Engl)*. 2010;19:145–66.
2. Cil TD, McCready D. Modern approaches to the surgical management of malignant breast disease: the role of breast conservation, complete mastectomy, skin- and nipple-sparing mastectomy. *Clin Plast Surg*. 2018;45(1):1–11.
3. Jones C, Lancaster R. Evolution of operative technique for mastectomy. *Surg Clin North Am*. 2018;98(4):835–44.
4. Magnoni F, Galimberti V, Corso G, Intra M, Sacchini V, Veronesi P. Axillary surgery in breast cancer: an updated historical perspective. *Semin Oncol*. 2020;47(6):341–52.
5. Maes-Carballo M, Gómez-Fandiño Y, Reinoso-Hermida A, et al. Quality indicators for breast cancer care: a systematic review. *Breast*. 2021;59:221–31.
6. Biganzoli L, Marotti L, Hart CD, et al. Quality indicators in breast cancer care: an update from the EUSOMA working group. *Eur J Cancer*. 2017;86:59–81.
7. Biganzoli L, Cardoso F, Beishon M, et al. The requirements of a specialist breast centre. *Breast*. 2020;51:65–84.
8. Landercasper J, Bailey L, Buras R, et al. The American Society of Breast Surgeons and quality payment programs: ranking, defining, and benchmarking more than 1 million patient quality measure encounters. *Ann Surg Oncol*. 2017;24(10):3093–106.
9. National Accreditation Program for Breast Centres. Standards Manual. 2018 [Retrieved Jan 17, 2022]. Available from: https://www.facs.org/-/media/files/quality-programs/napbc/napbc_standards_manual_2018.ashx
10. National Institute for Health and Care Excellence. Breast cancer quality standard (QS12). 2016 [retrieved Jan 17 2022]. Available from: https://www.nice.org.uk/guidance/qs12/chapter/List-of-quality-statements
11. Royal Australian College of Surgeons. Benefits of participating and performance indicators. [retrieved Jan 16 2022]. Available from: https://www.surgeons.org/research-audit/morbidity-audits/morbidity-audits-managed-by-racs/breastsurganz-quality-audit/benefits-of-participating-performance-indicators
12. Salindera S, Ogilvy M, Spillane A. What are the appropriate thresholds for high quality performance indicators for breast surgery in Australia and New Zealand? *Breast*. 2020;51:94–101.
13. Hughes L, Hamm J, McGahan C, Baliski C. Surgeon volume, patient age, and tumor-related factors influence the need for re-excision after breast-conserving surgery. *Ann Surg Oncol*. 2016;23(Suppl 5):656–64.
14. Isaacs AJ, Gemignani ML, Pusic A, Sedrakyan A. Association of breast conservation surgery for cancer with 90-day reoperation rates in new york state. *JAMA Surg*. 2016;151(7):648–55.
15. Lovrics PJ, Cornacchi SD, Farrokhyar F, et al. Technical factors, surgeon case volume and positive margin rates after breast conservation surgery for early-stage breast cancer. *Can J Surg*. 2010;53(5):305–12.
16. McDermott AM, Wall DM, Waters PS, et al. Surgeon and breast unit volume-outcome relationships in breast cancer surgery and treatment. *Ann Surg*. 2013;258(5):808–14.
17. Taban F, Elia N, Rapiti E, et al. Impact of experience in breast cancer surgery on survival: the role of quality of care in a registry-based cohort. *Swiss Med Wkly*. 2019;149:w14704.
18. Clifford EJ, De Vol EB, Pockaj BA, Wilke LG, Boughey JC. Early results from a novel quality outcomes program: the American society of Breast Surgeons' Mastery of Breast Surgery. *Ann Surg Oncol*. 2010;17(Suppl 3):233–41.
19. Dooley WC, Bong J, Parker J. Mechanisms of improved outcomes for breast cancer between surgical oncologists and general surgeons. *Ann Surg Oncol*. 2011;18(12):3248–51.
20. Eberth JM, Xu Y, Smith GL, et al. Surgeon influence on use of needle biopsy in patients with breast cancer: a national Medicare study. *J Clin Oncol*. 2014;32(21):2206–16.
21. Smith BD, Lei X, Diao K, et al. Effect of surgeon factors on long-term patient-reported outcomes after breast-conserving therapy in older breast cancer survivors. *Ann Surg Oncol*. 2020;27(4):1013–22.
22. De La Cruz L, Blankenship SA, Chatterjee A, et al. Outcomes after oncoplastic breast-conserving surgery in breast cancer patients: a systematic literature review. *Ann Surg Oncol*. 2016;23(10):3247–58.

23. Crown A, Handy N, Weed C, Laskin R, Rocha FG, Grumley J. Oncoplastic breast-conserving surgery: can we reduce rates of mastectomy and chemotherapy use in patients with traditional indications for mastectomy? *Ann Surg Oncol*. 2021;28(4):2199–209.
24. Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ*. 2021. https://doi.org/10.1136/bmj.n71.
25. Gu J, Groot G, Boden C, Busch A, Holtslander L, Lim H. Review of factors influencing women's choice of mastectomy versus breast conserving therapy in early stage breast cancer: a systematic review. *Clin Breast Cancer*. 2018;18(4):e539–54.
26. Roder D, Zorbas H, Kollias J, et al. Factors predictive of treatment by Australian breast surgeons of invasive female breast cancer by mastectomy rather than breast conserving surgery. *Asian Pac J Cancer Prev*. 2013;14(1):539–45.
27. Peltoniemi P, Huhtala H, Holli K, Pylkkänen L. Effect of surgeon's caseload on the quality of surgery and breast cancer recurrence. *Breast*. 2012;21(4):539–43.
28. Hershman DL, Buono D, Jacobson JS, et al. Surgeon characteristics and use of breast conservation surgery in women with early stage breast cancer. *Ann Surg*. 2009;249(5):828–33.
29. Chagpar AB, Studts JL, Scoggins CR, et al. Factors associated with surgical options for breast carcinoma. *Cancer*. 2006;106(7):1462–6.
30. Katz SJ, Lantz PM, Janz NK, et al. Surgeon perspectives about local therapy for breast carcinoma. *Cancer*. 2005;104(9):1854–61.
31. Najafi M, Ebrahimi M, Kaviani A, Hashemi E, Montazeri A. Breast conserving surgery versus mastectomy: cancer practice by general surgeons in Iran. *BMC Cancer*. 2005;5:35.
32. de Camargo Cancela M, Comber H, Sharp L. Hospital and surgeon caseload are associated with risk of re-operation following breast-conserving surgery. *Breast Cancer Res Treat*. 2013;140(3):535–44.
33. Burkholder HC, Witherspoon LE, Burns RP, Horn JS, Biderman MD. Breast surgery techniques: preoperative bracketing wire localization by surgeons. *Am Surg*. 2007;73(6):574–9.
34. Yen TWF, Laud PW, Pezzin LE, et al. Prevalence and consequences of axillary lymph node dissection in the era of sentinel lymph node biopsy for breast cancer. *Med Care*. 2018;56(1):78–84.
35. Morrow M, Jagsi R, McLeod MC, Shumway D, Katz SJ. Surgeon attitudes toward the omission of axillary dissection in early breast cancer. *JAMA Oncol*. 2018;4(11):1511–6.
36. Yen TW, Laud PW, Sparapani RA, Nattinger AB. Surgeon specialization and use of sentinel lymph node biopsy for breast cancer. *JAMA Surg*. 2014;149(2):185–92.
37. Quan ML, Hodgson N, Lovrics P, Porter G, Poirier B, Wright FC. National adoption of sentinel node biopsy for breast cancer: lessons learned from the Canadian experience. *Breast J*. 2008;14(5):421–7.
38. Porter GA, McMulkin H, Lovrics PJ. Sentinel lymph node biopsy in breast cancer: Canadian practice patterns. *Ann Surg Oncol*. 2003;10(3):255–60.
39. Posther KE, McCall LM, Blumencranz PW, et al. Sentinel node skills verification and surgeon performance: data from a multicenter clinical trial for early-stage breast cancer. *Ann Surg*. 2005;242(4):593–602.
40. Coromilas EJ, Wright JD, Huang Y, et al. The influence of hospital and surgeon factors on the prevalence of axillary lymph node evaluation in ductal carcinoma in situ. *JAMA Oncol*. 2015;1(3):323–32.
41. Vuong B, Dusendang JR, Chang SB, et al. Outpatient mastectomy: factors influencing patient selection and predictors of return to care. *J Am Coll Surg*. 2021;232(1):35–44.
42. Crown A, Wechter DG, Grumley JW. oncoplastic breast-conserving surgery reduces mastectomy and postoperative re-excision rates. *Ann Surg Oncol*. 2015;22(10):3363–8.
43. Baliski C, Hughes L, Bakos B. Lowering re-excision rates after breast-conserving surgery: unraveling the intersection between surgeon case volumes and techniques. *Ann Surg Oncol*. 2021;28(2):894–901.
44. Kaczmarski K, Wang P, Gilmore R, et al. Surgeon re-excision rates after breast-conserving surgery: a measure of low-value care. *J Am Coll Surg*. 2019;228(4):504-512.e2.
45. Landercasper J, Borgert AJ, Fayanju OM, et al. Factors associated with reoperation in breast-conserving surgery for cancer: a prospective study of American society of Breast Surgeon members. *Ann Surg Oncol*. 2019;26(10):3321–36.
46. McCahill LE, Single RM, Aiello Bowles EJ, et al. Variability in reexcision following breast conservation surgery. *JAMA*. 2012;307(5):467–75.
47. Pezzin LE, Laud P, Yen TW, Neuner J, Nattinger AB. Reexamining the relationship of breast cancer hospital and surgical volume to mortality: an instrumental variable analysis. *Med Care*. 2015;53(12):1033–9.
48. Hershman DL, Buono D, McBride RB, et al. Surgeon characteristics and receipt of adjuvant radiotherapy in women with breast cancer. *J Natl Cancer Inst*. 2008;100(3):199–206.
49. Tamirisa NP, Sheffield KM, Parmar AD, et al. Surgeon and facility variation in the use of minimally invasive breast biopsy in Texas. *Ann Surg*. 2015;262(1):171–8.
50. Lovrics PJ, Gordon M, Cornacchi SD, et al. Practice patterns and perceptions of margin status for breast conserving surgery for breast carcinoma: national survey of Canadian general surgeons. *Breast*. 2012;21(6):730–4.
51. Hershman DL, Richards CA, Kalinsky K, et al. Influence of health insurance, hospital factors and physician volume on receipt of immediate post-mastectomy reconstruction in women with invasive and non-invasive breast cancer. *Breast Cancer Res Treat*. 2012;136(2):535–45.
52. Hawley ST, Lantz PM, Janz NK, et al. Factors associated with patient involvement in surgical treatment decision making for breast cancer. *Patient Educ Couns*. 2007;65(3):387–95.
53. Waljee JF, Hawley S, Alderman AK, Morrow M, Katz SJ. Patient satisfaction with treatment of breast cancer: does surgeon specialization matter? *J Clin Oncol*. 2007;25(24):3694–8.
54. Morrow M, Abrahamse P, Hofer TP, et al. Trends in reoperation after initial lumpectomy for breast cancer: addressing overtreatment in surgical management. *JAMA Oncol*. 2017;3(10):1352–7.
55. Scher KS, Tisnado DM, Rose DE, et al. Physician and practice characteristics influencing tumor board attendance: results from the provider survey of the Los Angeles women's health study. *J Oncol Pract*. 2011;7(2):103–10.
56. Mukhtar RA, Wong J, Piper M, et al. Breast conservation and negative margins in invasive lobular carcinoma: the impact of oncoplastic surgery and shave margins in 358 patients. *Ann Surg Oncol*. 2018;25(11):3165–70.
57. Chauhan A, Sharma MM, Kumar K. Evaluation of surgical outcomes of oncoplasty breast surgery in locally advanced breast cancer and comparison with conventional breast conservation surgery. *Indian J Surg Oncol*. 2016;7(4):413–9.
58. Chauhan A, Sharma MM. Evaluation of surgical outcomes following oncoplastic breast surgery in early breast cancer and comparison with conventional breast conservation surgery. *Med J Armed Forces India*. 2016;72(1):12–8.

59. Losken A, Dugal CS, Styblo TM, Carlson GW. A meta-analysis comparing breast conservation therapy alone to the oncoplastic technique. *Ann Plast Surg*. 2014;72(2):145–9.
60. Losken A, Pinell-White X, Hart AM, Freitas AM, Carlson GW, Styblo TM. The oncoplastic reduction approach to breast conservation therapy: benefits for margin control. *Aesthet Surg J*. 2014;34(8):1185–91.
61. Kaur N, Petit JY, Rietjens M, et al. Comparative study of surgical margins in oncoplastic surgery and quadrantectomy in breast cancer. *Ann Surg Oncol*. 2005;12(7):539–45.
62. Behluli I, Le Renard PE, Rozwag K, Oppelt P, Kaufmann A, Schneider A. Oncoplastic breast surgery versus conventional breast-conserving surgery: a comparative retrospective study. *ANZ J Surg*. 2019;89(10):1236–41.
63. Kelemen P, Pukancsik D, Újhelyi M, et al. Comparison of clinicopathologic, cosmetic and quality of life outcomes in 700 oncoplastic and conventional breast-conserving surgery cases: A single-centre retrospective study. *Eur J Surg Oncol*. 2019;45(2):118–24.
64. Down SK, Jha PK, Burger A, Hussien MI. Oncological advantages of oncoplastic breast-conserving surgery in treatment of early breast cancer. *Breast J*. 2013;19(1):56–63.
65. Gulcelik MA, Dogan L, Yuksel M, Camlibel M, Ozaslan C, Reis E. Comparison of outcomes of standard and oncoplastic breast-conserving surgery. *J Breast Cancer*. 2013;16(2):193–7.
66. Chakravorty A, Shrestha AK, Sanmugalingam N, et al. How safe is oncoplastic breast conservation? Comparative analysis with standard breast conserving surgery. *Eur J Surg Oncol*. 2012;38(5):395–8.
67. Doğru V, Yaprak M, Durmaz E, et al. Oncoplastic approach to excisional breast biopsies: a randomized controlled, phase 2a trial. *Breast Cancer*. 2019;26(1):84–92.
68. Bali R, Kankam HKN, Borkar N, Provenzano E, Agrawal A. Wide local excision versus oncoplastic breast surgery: differences in surgical outcome for an assumed margin (0, 1, or 2 mm) distance. *Clin Breast Cancer*. 2018;18(5):e1053–7.
69. Broecker JS, Hart AM, Styblo TM, Losken A. Neoadjuvant therapy combined with oncoplastic reduction for high-stage breast cancer patients. *Ann Plast Surg*. 2017;78:S258–62.
70. Wijgman DJ, Ten Wolde B, van Groesen NR, Keemers-Gels ME, van den Wildenberg FJ, Strobbe LJ. Short term safety of oncoplastic breast conserving surgery for larger tumors. *Eur J Surg Oncol*. 2017;43(4):665–71.
71. Mansell J, Weiler-Mithoff E, Stallard S, Doughty JC, Mallon E, Romics L. Oncoplastic breast conservation surgery is oncologically safe when compared to wide local excision and mastectomy. *Breast*. 2017;32:179–85.
72. De Lorenzi F, Hubner G, Rotmensz N, et al. Oncological results of oncoplastic breast-conserving surgery: Long term follow-up of a large series at a single institution: a matched-cohort analysis. *Eur J Surg Oncol*. 2016;42(1):71–7.
73. Vieira RA, Carrara GF, Scapulatempo Neto C, Morini MA, Brentani MM, Folgueira MA. The role of oncoplastic breast conserving treatment for locally advanced breast tumors. A matching case-control study. *Ann Med Surg (Lond)*. 2016;10:61–8.
74. Mansell J, Weiler-Mithoff E, Martin J, et al. How to compare the oncological safety of oncoplastic breast conservation surgery - to wide local excision or mastectomy? *Breast*. 2015;24(4):497–501.
75. Giacalone PL, Roger P, Dubon O, et al. Comparative study of the accuracy of breast resection in oncoplastic surgery and quadrantectomy in breast cancer. *Ann Surg Oncol*. 2007;14(2):605–14.
76. Ojala K, Meretoja TJ, Leidenius MH. Aesthetic and functional outcome after breast conserving surgery - Comparison between conventional and oncoplastic resection. *Eur J Surg Oncol*. 2017;43(4):658–64.
77. Tenofsky PL, Dowell P, Topalovski T, Helmer SD. Surgical, oncologic, and cosmetic differences between oncoplastic and nononcoplastic breast conserving surgery in breast cancer patients. *Am J Surg*. 2014;207(3):398–402.
78. Mazouni C, Naveau A, Kane A, et al. The role of oncoplastic breast surgery in the management of breast cancer treated with primary chemotherapy. *Breast*. 2013;22(6):1189–93.
79. Carter SA, Lyons GR, Kuerer HM, et al. Operative and oncologic outcomes in 9861 patients with operable breast cancer: single-institution analysis of breast conservation with oncoplastic reconstruction. *Ann Surg Oncol*. 2016;23(10):3190–8.
80. Khan J, Barrett S, Forte C, et al. Oncoplastic breast conservation does not lead to a delay in the commencement of adjuvant chemotherapy in breast cancer patients. *Eur J Surg Oncol*. 2013;39(8):887–91.
81. De Lorenzi F, Loschi P, Bagnardi V, et al. Oncoplastic breast-conserving surgery for tumors larger than 2 centimeters: is it oncologically safe? a matched-cohort analysis. *Ann Surg Oncol*. 2016;23(6):1852–9.
82. Chand ND, Browne V, Paramanathan N, Peiris LJ, Laws SA, Rainsbury RM. Patient-reported outcomes are better after oncoplastic breast conservation than after mastectomy and autologous reconstruction. *Plast Reconstr Surg Glob Open*. 2017;5(7):e1419.
83. Veiga DF, Veiga-Filho J, Ribeiro LM, et al. Evaluations of aesthetic outcomes of oncoplastic surgery by surgeons of different gender and specialty: a prospective controlled study. *Breast*. 2011;20(5):407–12.
84. Kelsall JE, McCulley SJ, Brock L, Akerlund MTE, Macmillan RD. Comparing oncoplastic breast conserving surgery with mastectomy and immediate breast reconstruction: case-matched patient reported outcomes. *J Plast Reconstr Aesthet Surg*. 2017;70(10):1377–85.
85. Santos G, Urban C, Edelweiss MI, et al. Long-term comparison of aesthetical outcomes after oncoplastic surgery and lumpectomy in breast cancer patients. *Ann Surg Oncol*. 2015;22(8):2500–8.
86. Acosta-Marin V, Acosta-Freites V, Contreras A, et al. Oncoplastic breast surgery: initial experience at the Centro Clinico de Estereotaxia-CECLINES, Caracas. *Venezuela Ecancermedicalscience*. 2014;8:470.
87. de Oliveira-Junior I, Brandini da Silva FC, Nazima F, et al. Oncoplastic surgery: does patient and medical specialty influences the evaluation of cosmetic results? *Clin Breast Cancer*. 2021;21:247–55.
88. Cil TD, Cordeiro E. Complications of oncoplastic breast surgery involving soft tissue transfer versus breast-conserving surgery: an analysis of the NSQIP database. *Ann Surg Oncol*. 2016;23(10):3266–71.
89. Crown A, Scovel LG, Rocha FG, Scott EJ, Wechter DG, Grumley JW. Oncoplastic breast conserving surgery is associated with a lower rate of surgical site complications compared to standard breast conserving surgery. *Am J Surg*. 2019;217(1):138–41.
90. Angarita FA, Acuna SA, Cordeiro E, McCready DR, Cil TD. Does oncoplastic surgery increase immediate (30-day) postoperative complications? An analysis of the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. *Breast Cancer Res Treat*. 2020;182(2):429–38.
91. Jonczyk MM, Jean J, Graham R, Chatterjee A. Trending towards safer breast cancer surgeries? Examining acute complication rates from a 13-year NSQIP analysis. *Cancers (Basel)*. 2019;11(2):253.
92. Tong WMY, Baumann DP, Villa MT, et al. Obese women experience fewer complications after oncoplastic breast repair following partial mastectomy than after immediate total breast reconstruction. *Plast Reconstr Surg*. 2016;137(3):777–91.

93. DeSnyder SM, Hunt KK, Dong W, et al. American Society of Breast Surgeons' practice patterns after publication of the SSO-ASTRO-ASCO DCIS consensus guideline on margins for breast-conserving surgery with whole-breast irradiation. *Ann Surg Oncol*. 2018;25(10):2965–74.
94. Shaterian A, Saba SC, Yee B, et al. Single dual-trained surgeon for breast care leads to higher reconstruction rates after mastectomy. *World J Surg*. 2013;37(11):2600–6.
95. Zork NM, Komenaka IK, Pennington RE Jr, et al. The effect of dedicated breast surgeons on the short-term outcomes in breast cancer. *Ann Surg*. 2008;248(2):280–5.
96. Caudle AS, Bedrosian I, Milton DR, et al. Use of sentinel lymph node dissection after neoadjuvant chemotherapy in patients with node-positive breast cancer at diagnosis: practice patterns of American Society of Breast Surgeons members. *Ann Surg Oncol*. 2017;24(10):2925–34.
97. Meyer AM, Reeder-Hayes KE, Liu H, et al. Differential receipt of sentinel lymph node biopsy within practice-based research networks. *Med Care*. 2013;51(9):812–8.
98. Landercasper J, Whitacre E, Degnim AC, Al-Hamadani M. Reasons for re-excision after lumpectomy for breast cancer: insight from the American Society of Breast Surgeons Mastery(SM) database. *Ann Surg Oncol*. 2014;21(10):3185–91.
99. Kiderlen M, Ponti A, Tomatis M, et al. Variations in compliance to quality indicators by age for 41,871 breast cancer patients across Europe: a European Society of Breast Cancer Specialists database analysis. *Eur J Cancer*. 2015;51(10):1221–30.
100. van Dam PA, Tomatis M, Marotti L, et al. Time trends (2006–2015) of quality indicators in EUSOMA-certified breast centres. *Eur J Cancer*. 2017;85:15–22.
101. Angarita FA, Leroux ME, Palter VN, et al. Assessing the effect of a hands-on oncoplastic surgery training course: a survey of Canadian surgeons. *Surg Oncol*. 2020;35:428–33. https://doi.org/10.1016/j.suronc.2020.10.003.
102. American Society of Breast Surgeons. BESAP III. [Retrieved Sept 30, 2022]. Available from: https://www.breastsurgeons.org/education/besap.
103. Association of Breast Surgery. ABS Courses Portfolio. [Retrieved Sept 30, 2022]. Available from: https://associationofbreastsurgery.org.uk/courses-events/abs-courses-portfolio/.
104. American College of Surgeons. Oncoplastic Breast Surgery. [Retrieved Sept 30, 2022]. Available from: https://learning.facs.org/content/oncoplastic-breast-surgery#group-tabs-node-course-default1.
105. European Society of Surgical Oncology. ESSO Advanced Course on Oncoplastic Breast Surgery. [Retrieved Sept 30, 2022]. Available from: https://www.essoweb.org/courses/esso-advanced-course-oncoplastic-breast-surgery-2021/.
106. Peiris L, Olson D, Kelly D. Oncoplastic and reconstructive breast surgery in Canada: Breaking new ground in general surgical training. *Can J Surg*. 2018;61(5):294–9.
107. Rubio IT, Wyld L, Esgueva A, et al. Variability in breast cancer surgery training across Europe: An ESSO-EUSOMA international survey. *Eur J Surg Oncol*. 2019;45(4):567–72.
108. Wyld L, Rubio IT, Kovacs T. Education and training in breast cancer surgery in Europe. *Breast Care (Basel)*. 2019;14(6):366–72.
109. Sclafani LM, Bleznak A, Kelly T, El-Tamer MB. Training a new generation of breast surgeons: are we succeeding? *Ann Surg Oncol*. 2012;19(6):1856–61.
110. Greenup RA, Obeng-Gyasi S, Thomas S, Houck K, Lane WO, Blitzblau RC, Hyslop T, Hwang ES. The effect of hospital volume on breast cancer mortality. *Ann Surg*. 2018;267(2):375–81.
111. Okawa S, Tabuchi T, Morishima T, Koyama S, Taniyama Y, Miyashiro I. Hospital volume and postoperative 5-year survival for five different cancer sites: a population-based study in Japan. *Cancer Sci*. 2020;111(3):985–93.
112. Pezzin LE, Laud P, Yen TW, Neuner J, Nattinger AB. Reexamining the relationship of breast cancer hospital and surgical volume to mortality: an instrumental variable analysis. *Med Care*. 2015;53(12):1033–9.
113. Chaudhry R, Goel V, Sawka C. Breast cancer survival by teaching status of the initial treating hospital. *CMAJ*. 2001;164(2):183–8.
114. Katz SJ, Bondarenko I, Ward KC, et al. Association of attending surgeon with variation in the receipt of genetic testing after diagnosis of breast cancer. *JAMA Surg*. 2018;153(10):909–16.
115. Schulman AM, Mirrielees JA, Leverson G, Landercasper J, Greenberg C, Wilke LG. Reexcision surgery for breast cancer: an analysis of the American Society of Breast Surgeons (ASBrS) Mastery^{SM} Database following the SSO-ASTRO "no ink on tumor" guidelines. *Ann Surg Oncol*. 2017;24(1):52–8.
116. Alderman AK, Hawley ST, Waljee J, Morrow M, Katz SJ. Correlates of referral practices of general surgeons to plastic surgeons for mastectomy reconstruction. *Cancer*. 2007;109(9):1715–20.
117. Chagpar AB, Scoggins CR, Martin RC 2nd, et al. Factors determining adequacy of axillary node dissection in breast cancer patients. *Breast J*. 2007;13(3):233–7.
118. Hawley ST, Hofer TP, Janz NK, et al. Correlates of between-surgeon variation in breast cancer treatments. *Med Care*. 2006;44(7):609–16.
119. Campbell EJ, Romics L. Oncological safety and cosmetic outcomes in oncoplastic breast conservation surgery, a review of the best level of evidence literature. *Breast Cancer (Dove Med Press)*. 2017;9:521–30.
120. Losken A, Schaefer TG, Newell M, Styblo TM. The impact of partial breast reconstruction using reduction techniques on postoperative cancer surveillance. *Plast Reconstr Surg*. 2009;124(1):9–17.