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Rates of reoperation after breast conserving cancer surgery in Western Australia before and after publication of the SSO-ASTRO margins guideline

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ABSTRACT

Background: A 2014 SSO-ASTRO guideline on surgical margins aimed to reduce unnecessary reoperation after breast conserving surgery (BCS). We investigate whether publication of the guideline was associated with a reduction in reoperation in Western Australia (WA).

Methods: In this retrospective, population-based cohort study, cases of newly-diagnosed breast cancer were identified from the WA Cancer Registry. Linkage to the Hospital Morbidity Data Collection identified index BCS for invasive cancer between January 2009 and June 2018 (N = 8059) and reoperation within 90 days. Pre-guideline (2009–2013) and post-guideline (2014–2018) reoperation proportions were compared, and temporal trends were estimated with generalised linear regression.

Results: The pre-guideline reoperation proportion was 25.8% compared with 21.7% post-guideline (difference −4.0% [95% CI —5.9, −2.2, $p < 0.001$], odds ratio [OR] 0.80 [95% CI 0.72, 0.89, $p < 0.001$]). Absolute reductions were similar for repeat BCS (16.3% versus 14.6%; difference −1.8% [95% CI —3.4, −0.2, $p = 0.03$]) and conversion to mastectomy (9.4% versus 7.2%; difference −2.2% [95% CI —3.4, −1.0, $p < 0.001$]). Over the study period, there was an annual absolute change in reoperation of −0.8% (95% CI —1.2, −0.5, $p < 0.001$). Accounting for this linear trend, the difference in reoperation between time periods was −0.5% (95% CI —4.3, 3.3; $p = 0.81$), reflecting a non-significant reduction in conversion to mastectomy.

Conclusions: Comparisons of pre- versus post-guideline time periods in WA showed reductions in reoperation that were similar to international estimates; however, an annual decline in reoperation predated the guideline. Analyses that do not account for temporal trends are likely to overestimate changes in reoperation associated with the guideline.

1. Introduction

Breast conserving surgery (BCS) is standard treatment for early breast cancer. BCS involves removal of the cancer along with a surrounding area of normal tissue (the "margin"). Historically, the optimum margin distance, balancing cancer control with treatment morbidity and cosmetic outcomes, has been controversial. In 2014, the Society of Surgical Oncology (SSO) and the American Society for Radiation Oncology (ASTRO) developed an evidence-based consensus guideline on margins for BCS for early-stage invasive breast cancer [1]. The guideline was underpinned by meta-analyses [2,3] that found that wider margins distances did not statistically significantly decrease rates of local recurrence compared with a minimal negative margin width. In recommending a minimal (no-ink-on-tumour) definition of a negative margin, the SSO-ASTRO guideline sought to standardise surgical practice and to reduce overtreatment associated with obtaining wider margins, including repeat BCS or conversion from BCS to mastectomy.

Numerous studies have compared rates of reoperation in the periods before and after publication of the SSO-ASTRO guideline as a measure of its clinical impact. A systematic review and meta-analysis of population-based studies found that the pooled odds of reoperation after BCS were lower in the post-guideline period by approximately one-quarter [4]. However, other practice changes in surgical oncology may have contributed to reduced reoperation rates over time [5,6]. Dichotomous

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comparisons of time periods may therefore obscure temporal trends in reoperation that are independent of the guideline and can potentially confound observed differences. Previous studies have been limited by generally short timeframes used to define both the pre- and post-guideline periods. For example, studies have commonly compared reoperation rates in the year prior to the guidelines with the following one [7,8] or two years [9–11]. It is difficult to observe temporal trends within guideline periods from these small numbers of observations [12].

In this population-based study, we investigate rates of reoperation after BCS for invasive cancer in Western Australia over the period 2009–2018 (i.e. five years before and after publication of the SSO-ASTRO guideline). In addition to dichotomous comparisons between guideline periods, we explore trends in reoperation over time, and account for such trends in estimating changes in reoperation rates associated with publication of the guideline.

2. Methods

2.1. Cohort selection and characteristics

We conducted a population-based, longitudinal cohort study of women in Western Australia (WA) who had breast conserving surgery (BCS) as their first treatment for newly-diagnosed invasive breast cancer between January 2009 and June 2018. Male breast cancer was not considered in the SSO-ASTRO guideline and was therefore excluded from this cohort. Women with a first diagnosis of primary invasive breast cancer were identified from the WA Cancer Registry, and hospital admission records for those women (starting 12 months prior to the date of diagnosis) were extracted from the Hospital Morbidity Data Collection. First (index) hospital admissions for BCS between January 2009 and June 2018 were identified using Australian Classification of Health Interventions (ACHI) procedure code 31500–00 (Excision of lesion of breast) with an associated ICD-10-AM diagnosis code C50 (Malignant neoplasm of breast).

2.2. Exposure definition

The SSO-ASTRO guideline was first published online in February 2014 [1]. The year of index BCS admission was therefore classified as being in either the pre-guideline (2009–2013) or post-guideline (2014–2018) period.

2.3. Reoperation outcome definition

A reoperation outcome was defined as a subsequent hospital admission for repeat BCS (ACHI code 31515–00) or conversion to mastectomy (ACHI codes 31524–01, 31524–00, 31518–01, 31518–00) within 90 days of the index admission. Consistent with previous studies [6], BCS followed by mastectomy in the same index admission was classified as initial mastectomy, and such cases were excluded from the cohort. BCS followed by repeat BCS in the same index admission was classified as initial BCS; the repeat BCS was not classified as a reoperation event. For women with multiple surgical readmissions in the follow-up period, the most extensive procedure was used to classify the type of reoperation.

The follow-up period of 90 days to define reoperation is consistent with previous studies [13]. A sensitivity analysis was undertaken in which reoperation was defined as repeat BCS or mastectomy within 365 days of the index BCS admission to account for reoperation after chemotherapy [6]. To accommodate the additional period of follow-up, index admissions from 2018 could not be included in this analysis.

Ethical approval

This research was approved by the Department of Health WA Human Research Ethics Committee and the Curtin University Human Research Ethics Committee. Ethical approval did not permit summarising participant information by race/ethnicity.

2.4. Statistical methods

Characteristics of the cohort were summarised descriptively using means for age and percentages for categorical variables, and differences between the pre-guideline and post-guideline periods were assessed by t-tests or Chi-squared tests, as appropriate. The univariable association between guideline period and reoperation proportion was estimated, as in previous studies assessing the SSO-ASTRO guideline. Reoperation proportions in the post- vs pre-guideline periods, their absolute difference, and the odds ratio (OR) for reoperation were calculated along with Wald 95% confidence intervals (95% CIs).

Scatterplots were constructed to display the reoperation proportion by year of index admission. Interrupted time-series analysis [12] using generalised linear regression (PROC GENMOD with binomial distribution and identity link in SAS) was used to investigate the univariable association between year of index admission and reoperation proportion. The slope parameter, representing the absolute change in reoperation proportion per year, was tested for linear trend. We then estimated the association between guideline period and reoperation proportion controlling for year of admission. The parameter estimate for guideline period represents the "level change" in reoperation rate at the time-point of publication of the SSO-ASTRO guideline (2014), accounting for pre-guidelines trend [12]. The interaction between guideline period and year of admission was tested to assess whether the yearly change in reoperation differed between the guideline periods. When the interaction term was not statistically significant it was omitted from the reported model. Statistical significance was assessed by the likelihood ratio test. The OR for guideline period from the multivariable model was also estimated for comparison with the univariable estimate.

In addition to the overall reoperation proportion, separate analyses were undertaken for the outcomes of repeat BCS and conversion to mastectomy. Analyses were also stratified by hospital type (metropolitan tertiary/public versus metropolitan private) and age group (<50 years versus ≥50 years). Both unadjusted and adjusted analyses were undertaken. Covariates in adjusted analyses were age at index admission (continuous), indigenous status (dichotomous), socioeconomic status (SES) quintile (categorical), comorbidities (dichotomous), and hospital type (categorical). SES was derived from the Australian Bureau of Statistics Index of Relative Socioeconomic Disadvantage, a geographic area-level composite of education, skilled occupation status, and household income [14]. Comorbidities were derived using the ICD-10 version of the Multipurpose Australian Comorbidity Scoring System based on admissions within 365 days prior to the index BCS admission [15]. Adjustment for residential location at time of diagnosis (categorical) instead of hospital type was undertaken as a sensitivity analysis.

Analyses were undertaken in SAS 9.4 (SAS Institute North Carolina, US). All tests of statistical significance were two-sided. The level chosen for statistical significance was $p < 0.05$; $p < 0.10$ was considered to represent weak evidence of association.

3. Results

3.1. Cohort characteristics

The cohort consisted of 8059 women with invasive cancer at index BCS admission during the study period (3903 pre-guideline, 4156 post-guideline) (Fig. S1). Pre- and post-guideline cohorts were generally comparable, with small differences in mean age (58.8 vs 60.2 years, $p < 0.001$) and the distributions of hospital type ($p < 0.001$) being statistically significant due to the relatively large sample size (Table 1). SES quintile, number of comorbidities, and residential location did not differ between the cohorts.

Table 1
Characteristics of Western Australian women with invasive breast cancer at index BCS admission.

	Full cohort (2009–2018) N = 8059		Pre-guideline (2009–2013) N = 3903		Post-guideline (2014–2018) N = 4156		
	N	Mean (sd) or %	N	Mean (sd) or %	N	Mean (sd) or %	p-value
Age, years	8059	59.5 (12.0)	3903	58.8 (12.0)	4156	60.2 (12.0)	<0.001
Age group							
<50 years	1742	21.6%	907	23.2%	835	20.1%	<0.001
≥50 years	6317	78.4%	2996	76.8%	3321	79.9%	
SES quintile[a]							
1	1692	21.1%	861	22.2%	831	20.1%	0.17
2	1586	19.8%	753	19.4%	833	20.1%	
3	1623	20.2%	772	19.9%	851	20.6%	
4	1542	19.2%	754	19.4%	788	19.1%	
5	1576	19.7%	742	19.1%	834	20.2%	
Comorbidities[a]							
0	4232	53.0%	2067	53.3%	2165	52.7%	0.91
1	2394	30.0%	1150	29.7%	1244	30.3%	
2	712	8.9%	349	9.0%	363	8.8%	
≥3	646	8.1%	310	8.0%	336	8.2%	
Residential location[a]							
Major city	6261	77.9%	3012	77.5%	3249	78.3%	0.76
Inner regional	876	10.9%	434	11.2%	442	10.7%	
Outer regional	638	7.9%	307	7.9%	331	8.0%	
Remote/very remote	261	3.3%	132	3.4%	129	3.1%	
Hospital type							
Tertiary	2574	31.9%	1248	32.0%	1326	31.9%	<0.001
Public Metro	222	2.7%	77	2.0%	145	3.5%	
Private Metro	4455	55.3%	2211	56.7%	2244	54.0%	
Rural	808	10.0%	367	9.4%	441	10.6%	

Abbreviations: BCS, breast conserving surgery; CI, confidence interval; sd, standard deviation.
[a] Missing data: SES, N = 40; Comorbidities, N = 75; Residential location, N = 23.

3.2. All reoperations

The reoperation proportion decreased from 25.8% pre-guidelines to 21.7% post-guidelines, an absolute difference of −4.0% (95% CI —5.9, −2.2, p < 0.001) (Table 2). The OR for reoperation (post- vs pre-guideline) was 0.80 (95% CI 0.72, 0.89, p < 0.001).

Plots of reoperation proportions by year of index admission show a negative linear relationship (decrease) across the study period (Fig. 1). There was a −0.8% per year absolute reduction in reoperation proportion across the entire study period (p < 0.001) (Table 3). There was no evidence that the yearly reduction was different between guideline periods (−0.8% per year pre-guideline, −0.7% per year post-guideline; p = 0.79). Taking this linear trend into account, the *additional* reduction in reoperation proportion in the post-guideline period was −0.5% (p = 0.81). The corresponding OR for reoperation was 0.97 (p = 0.79).

3.3. Repeat BCS and conversion to mastectomy

The repeat BCS proportion decreased from 16.3% pre-guidelines to 14.6% post-guidelines, an absolute difference of −1.8% (p = 0.03) (Table 2). The OR for repeat BCS was 0.87 (p = 0.03). Conversion to mastectomy decreased from 9.4% pre-guidelines to 7.4% post-guidelines, an absolute difference of −2.2% (p < 0.001) with an OR of 0.75 (p < 0.001) (Table 2).

There was a −0.4% per year reduction in repeat BCS (p = 0.01) and a −0.4% per year reduction in conversion to mastectomy (p < 0.001) (Fig. 1, Table 3). There was no evidence that the yearly reduction differed between these outcomes (*P* = 0.71), or between guideline periods (p = 0.95 for repeat BCS; p = 0.80 for conversion to mastectomy). Accounting for linear trends, there was no *additional* reduction in repeat BCS proportion associated with the post-guideline period (0.0%; p = 1.00). The *additional* reduction in conversion to mastectomy proportion in the post-guideline period was −0.5% (p = 0.71).

3.4. Stratification by hospital type (tertiary/public versus private)

The reoperation proportion in metropolitan tertiary/public hospitals decreased from 19.3% pre-guidelines to 17.2%% post-guidelines, an

Table 2
Reoperation within 90 days of admission: Dichotomous comparison of pre- and post-guideline periods.

	Reoperation % [95% CI]		Absolute difference post- vs pre- [95% CI]	p-value for difference	Odds ratio post- vs pre-[95% CI]
	Pre-guideline (2009–2013)	Post-guideline (2014–2018)			
Reoperation outcome					
All reoperations	25.8% [24.4, 27.1]	21.7% [20.5, 23.0]	−4.0% [−5.9, −2.2]	<0.001	0.80 [0.72, 0.89]
Repeat BCS	16.3% [15.2, 17.5]	14.6% [13.5, 15.6]	−1.8% [−3.4, −0.2]	0.03	0.87 [0.77, 0.98]
Conversion to mastectomy	9.4% [8.5, 10.3]	7.2% [6.4, 8.0]	−2.2% [−3.4, −1.0]	<0.001	0.75 [0.63, 0.87]
Metropolitan hospital type					
Tertiary/public	19.3% [17.2, 21.5]	17.2% [15.3, 19.1]	−2.1% [−5.0, 0.8]	0.15	0.87 [0.72, 1.05]
Private	29.8% [27.9, 31.7]	25.3% [23.5, 27.1]	−4.5% [−7.1, −1.9]	<0.001	0.80 [0.70, 0.91]
Age group					
<50 years	31.6% [28.6, 34.7]	28.0% [25.0, 31.1]	−3.6% [−7.9, 0.7]	0.10	0.84 [0.69, 1.03]
≥50 years	24.0% [22.5, 25.5]	20.2% [18.8, 21.5]	−3.8% [−5.9, −1.8]	<0.001	0.80 [0.71, 0.90]

Abbreviations: BCS, breast conserving surgery; CI, confidence interval.

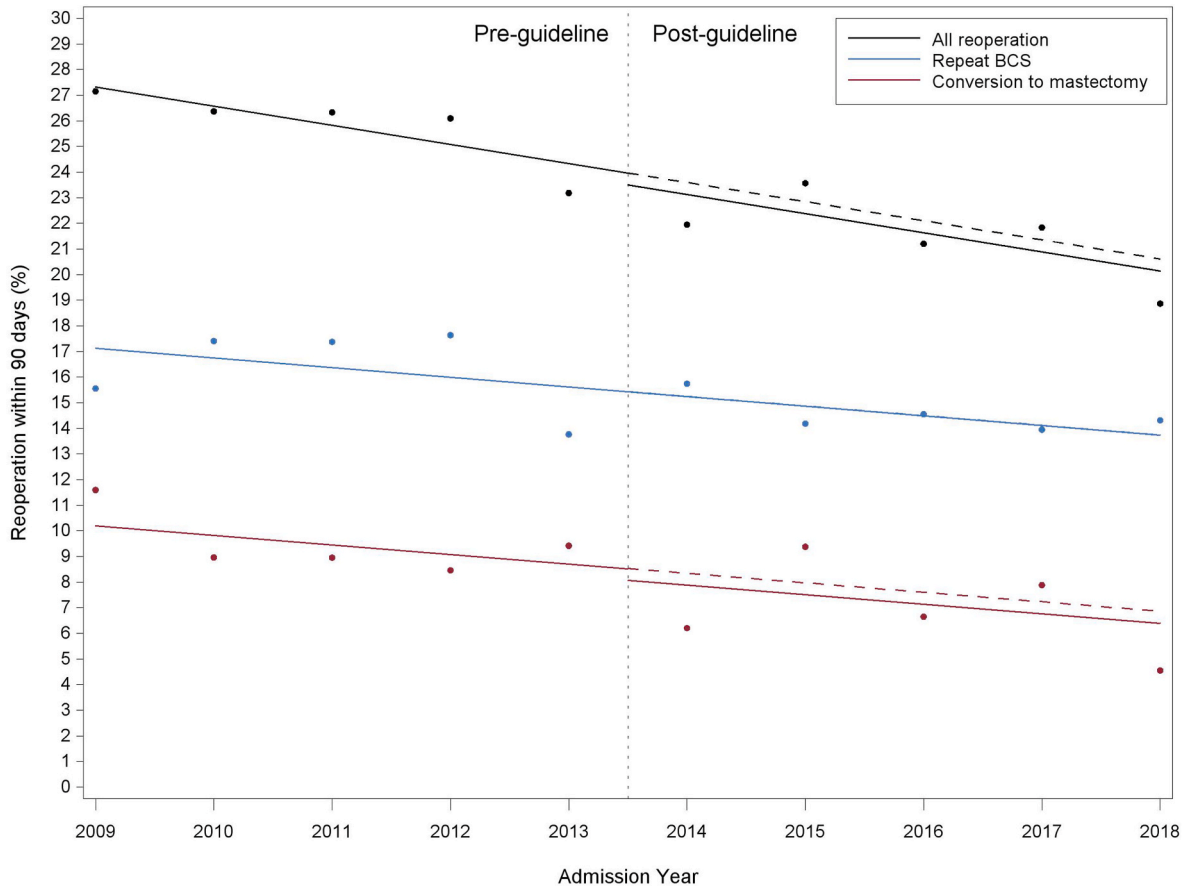

Fig. 1. Percentages of all reoperations, repeat BCS, and conversion to mastectomy within 90 days by year of the index BCS admission. Solid lines represent modelled trend for each guideline period; dashed lines represent predicted continuation of pre-guideline trend.

Table 3
Reoperation within 90 days of admission: Overall linear trend by admission year, and comparison of linear trends between guideline periods.

	Overall linear trend for admission year		Comparison of linear trends post- vs pre- guidelines				
	Change per year % [95% CI]	p-value for change	Change per year % [95% CI]	p-value for change	Additional difference post- vs pre- [95% CI]	p-value for difference	Odds ratio post- vs pre- [95% CI]
Reoperation outcome							
All reoperations	−0.8% [−1.2, −0.5]	<0.001	−0.7% [−1.4, 0.1]	0.03	−0.5% [−4.3, 3.3]	0.81	0.97 [0.79, 1.20]
Repeat BCS	−0.4% [−0.7, −0.1]	0.01	−0.4% [−0.8, 0.3]	0.21	0.0% [−3.2, 3.2]	1.00	1.00 [0.78, 1.27]
Conversion to mastectomy	−0.4% [−0.7, −0.2]	<0.001	−0.4% [−0.8, 0.1]	0.11	−0.5% [−2.9, 2.0]	0.71	0.94 [0.68, 1.29]
Metropolitan hospital type							
Tertiary/public	−0.7% [−1.2, −0.1]	0.01	−1.4% [−2.5, −0.3]	0.009	4.7% [−1.2, 10.5]	0.12	1.36 [0.92, 2.02]
Private	−0.9% [−1.4, −0.4]	<0.001	−0.7% [-1.7, 0.3]	0.17	−1.2% [-6.5, 4.1]	0.65	0.94 [0.72, 1.22]
Age group							
<50 years	−0.6% [−1.4, 0.2]	0.12	−0.2% [−1.8, 1.4]	0.83	−2.8% [−11.5, 5.9]	0.53	0.88 [0.58, 1.33]
≥50 years	−0.8% [−1.2, −0.4]	<0.001	−0.8% [−1.6, −0.1]	0.04	0.0% [−4.1, 4.2]	0.99	1.00 [0.78, 1.27]

Abbreviations: BCS, breast conserving surgery; CI, confidence interval.

absolute difference of −2.1% (p = 0.15) with an odds ratio of 0.87 (p = 0.15) (Table 2). The reoperation proportion in metropolitan private hospitals decreased from 29.8% pre-guidelines to 25.3% post-guidelines, an absolute difference of −4.5% (p < 0.001) with an odds ratio of 0.80 (p < 0.001). There was no evidence that absolute reduction differed between hospital types (p = 0.23).

For tertiary/public hospitals, the overall annual decrease in reoperation was −0.7% (p = 0.01) (Fig. 2A, Table 3). The annual decrease within each guideline period was double that estimate (−1.4%, p = 0.009), but with a non-significant increase in reoperation associated with introduction of the guideline (4.7%; p = 0.12) (Table 3). For private hospitals, there was a −0.7% (p = 0.17) annual decrease in reoperation in both periods, with an *additional* reduction in reoperation in the post-guideline of −1.2% (p = 0.65) (Fig. 2B, Table 3).

3.5. Stratification by age group (<50 years versus ≥50 years)

The reoperation proportion in women aged <50 years decreased from 31.6% pre-guidelines to 28.0% post-guidelines, an absolute difference of −3.6% (p = 0.10) with an odds ratio of 0.84 (p = 0.10) (Table 2). The reoperation proportion in women aged ≥50 years decreased from 24.0% pre-guidelines to 20.2% post-guidelines, an absolute difference of −3.8% (p < 0.001) with an odds ratio of 0.80 (p < 0.001). There was no evidence that the absolute reduction differed

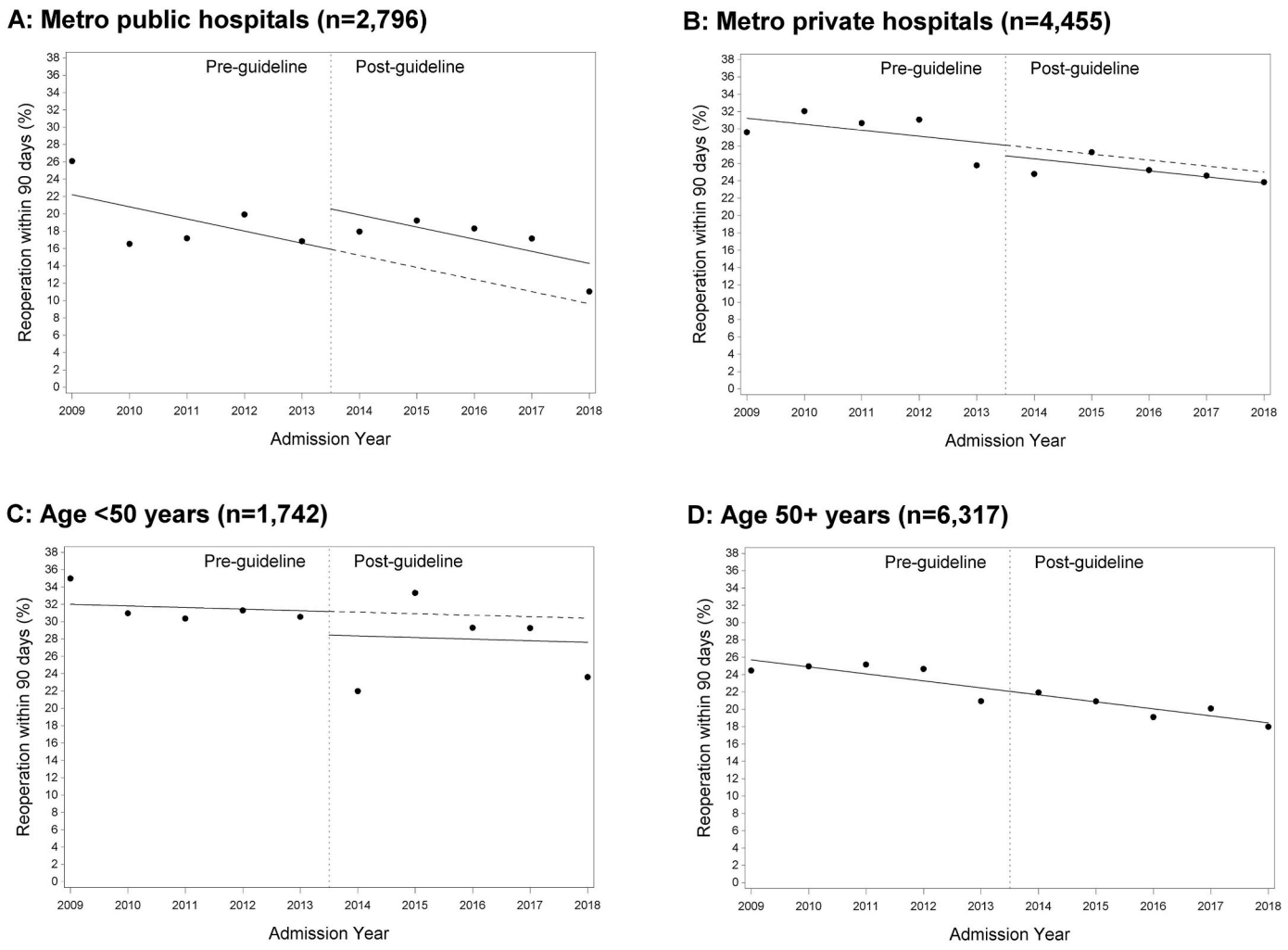

Fig. 2. Percentages of all reoperations within 90 days by year of the index BCS admission in A) metro tertiary/public hospitals; B) metro private hospitals; C) women aged <50 years; and D) women aged ≥50 years. Solid lines represent modelled trend for each guideline period; dashed lines represent predicted continuation of pre-guideline trend.

between age groups (p = 0.93).

For women aged ≥50 years, the annual decrease in reoperation was −0.8% (p < 0.001). Accounting for this trend, there was no additional change in reoperation associated with the guideline (0.0%; p = 0.99) (Fig. 2D, Table 3). For women aged <50 years, the annual decrease in reoperation over the entire study period was −0.6% (p = 0.12). Within each guideline period, there was a −0.2% per year decrease in reoperation for women aged <50 years (p = 0.83) (Table 3). The *additional* reduction in reoperation in the post-guideline period was −2.8% (p = 0.53).

3.6. Statistical adjustment and sensitivity analyses

Adjustment for potential confounders did not substantially change estimates in the main analyses (Tables S1 and S2). Results did not change with adjustment for residential location (categorical) instead of hospital type (data not shown).

Sensitivity analyses were undertaken to extend the follow-up period for reoperation to 365 days after the index BCS admission. As expected, reoperation percentages were higher compared with the primary analysis; however, changes in reoperation over time were generally consistent (Tables S3 and S4; Figs. S2 and S3). Comparison of plots suggest that small differences between analyses are attributable to the exclusion of index admissions from 2018 to allow for the extended follow-up.

4. Discussion

The SSO-ASTRO consensus guideline on BCS margins for early invasive breast cancer aimed to minimise variation in surgical practice and reduce overtreatment, specifically reoperation to achieve widely negative margins [1]. Evidence about clinical uptake of the guideline suggests that the recommendation for a no-tumour-on-ink definition of negative margins contributed to an overall reduction in reoperation rates, particularly in the United States (US), with the potential for clinical benefits to women through the avoidance of surgical morbidity coupled with economic benefits for health systems [4]. In this study of reoperation in Western Australia, we observed a −4.0% absolute reduction in reoperation rates in the five years after publication of the guideline (21.7%) relative to the five years prior (25.8%), with an associated OR for reoperation of 0.80. Those estimates are comparable to findings from previous international population-based studies (e.g. reoperation rate of 21.6% versus 25.3%, OR = 0.81 from one US study [16]; pooled OR = 0.76 from meta-analysis of four studies [4]).

The ten-year timeframe of our cohort (2009–2018) allowed for the investigation of temporal trends in reoperation rates. We observed a trend for declining rates of reoperation over that period (for both repeat BCS and conversion to mastectomy), with a mean absolute reduction of −0.8% per year. This finding is consistent with a long-term trend for lower rates of reoperation over time in Western Australia observed in

earlier time periods [6]. In our contemporary cohort, the trend may reflect practice changes that occurred independently of the SSO-ASTRO guideline such as the adoption of intraoperative ultrasound guided surgery and cavity shave margins, both of which are associated with reduced rates of reoperation [17,18] and may confound dichotomous comparisons between pre- and post-guideline periods. Such comparisons should therefore be interpreted in the context of the background trend. We found no evidence that the guideline was associated with a hastening (or slowing) of the trend for annual reductions in reoperation, nor in a statistically significant reduction in reoperation over and above the background trend. The small, non-significant additional reduction in reoperation associated with the guideline (−0.5%) reflected a change in conversion to mastectomy but not a reduction in repeat BCS.

When our interrupted time series analyses were stratified by hospital type and age group, additional changes in reoperation associated with the guideline were not statistically significant for any of the strata. An increase in reoperation (4.7%) observed for metropolitan tertiary/public hospitals is likely to be a statistical artefact of the influence (leverage) on regression results from comparatively high and low rates in the first and last years of the cohort, respectively; reoperation rates were relatively constant in the intervening years (Fig. 2A). It is possible that the guideline was associated with a greater reduction in reoperation for younger women (−2.8% for women aged <50 years compared with no change for women aged ≥50), but smaller numbers in this subgroup resulted in reduced statistical power. However, this difference is plausible given overall higher baseline reoperation rates in the <50 years age group (Table 2).

Few studies that have assessed adoption of the SSO-ASTRO guidelines have tracked reoperation rates over long time periods and employed interrupted time series analyses such as those presented in our study. One US population-based study that used the National Cancer Database to plot rates of repeat operation over time did not show the sustained negative linear trend in the pre-guideline period that was evident here, but did observe a marked reduction in reoperation that coincided with the year of publication of the guideline [19]. The Australian context may differ from the US, where the impact of the guideline may have been greater. For example, most breast cancer surgery in Australia is performed by specialist breast surgeons operating within multidisciplinary teams, with high quality surgical outcomes even before the guidelines [20], whereas a large proportion of women in the US have initial surgical treatment in non-specialist community general surgery practices [21]. There is a potential for the guidelines to have a greater influence on practice in a non-specialist setting.

A limitation of our analysis relates to the assumption of an ongoing background trend in the post-guideline period. It is assumed that the annual decline in reoperation observed in 2009–2013 would have continued identically in 2014–2018 had the SSO-ASTRO guideline not been published. Our analysis calculated a constant change in reoperation associated with the guideline *in addition to* the assumed ongoing trend. The validity of the assumption of an ongoing trend cannot be tested; however, an alternative plausible assumption is that after a sustained period of annual decline, reoperation rates may have plateaued between 2014 and 2018 in the absence of the guideline. In that scenario, our estimate of the additional reduction in reoperation attributable the guideline would apply only to the first post-guideline year (2014), with incrementally greater reductions relative to the alternative scenario in subsequent years. Therefore, while simple dichotomous comparisons of pre- and post-guideline periods are likely to overestimate changes in reoperation by not accounting for temporal trends, our alternative analysis may have underestimated those changes. The true absolute reduction in reoperation attributable to the guideline is therefore likely to lie within the range of estimates from these two approaches (i.e. between −0.5% and −4.0%).

"Natural experiments" that observe changes in outcomes before and after an intervention are inherently susceptible to confounding; however, analyses that account for temporal trends in longitudinal data provide a stronger methodology for inferring causal associations [12]. Our findings highlight the importance of considering background temporal trends when assessing changes in reoperation rates associated with publication of the SSO-ASTRO consensus margins guideline. Dichotomous comparisons of the pre- and post-guideline periods in Western Australia showed reductions in reoperation that were comparable to international findings, but accounting for declining rates over time suggested that those reductions are likely to be overestimates. Although these findings are likely to be specific to a Western Australian context and may not reflect circumstances in other settings (where temporal trends may be different and the impact of the guideline may be greater), future studies seeking to estimate the magnitude of changes in reoperation should be encouraged to utilise regression-based approaches that account for longitudinal trends in surgical outcomes.

Declaration of competing interest

MLM and NH contributed to the meta-analyses that supported the SSO/ASTRO guideline. NH contributed to the development of the SSO/ASTRO guideline. The other authors declare no conflicts of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.breast.2023.01.013.

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