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Patterns of immediate breast reconstruction in New South Wales, Australia: a population-based study

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Key words

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Abstract

Background: The rate of immediate breast reconstruction (IBR) following mastectomy for breast cancer in Australia is low and varies between regions. To date, no previous Australian studies have examined IBR rates between all hospitals within a particular jurisdiction, despite hospitals being an important known contributor to variation in IBR rates in other countries.

Methods: We used cross-classified random-effects logistic regression models to examine the inter-hospital variation in IBR rates by using data on 7961 women who underwent therapeutic mastectomy procedures in New South Wales (NSW) between January 2012 and June 2015. We derived IBR rates by patient-, residential neighbourhood- and hospital-related factors and investigated the underlying drivers for the variation in IBR.

Results: We estimated the mean IBR rate across all hospitals performing mastectomy to be 17.1% (95% Bayesian credible interval (CrI) 12.1–23.1%) and observed wide inter-hospital variation in IBR (variance 4.337, CrI 2.634–6.889). Older women, those born in Asian countries (odds ratio (OR) 0.5, CrI 0.4–0.6), residing in neighbourhoods with lower socioeconomic status (OR 0.7, CrI 0.5–0.8 for the most disadvantaged), and who underwent surgery in public hospitals (OR 0.4, CrI 0.1–1.0) were significantly less likely to have IBR. Women residing in non-metropolitan areas and attending non-metropolitan hospitals were significantly less likely to undergo IBR than their metropolitan counterparts attending metropolitan hospitals.

Conclusion: Wide inter-hospital variation raises concerns about potential inequities in access to IBR services and unmet demand in certain areas of NSW. Explaining the underlying drivers for IBR variation is the first step in identifying policy solutions to redress the issue.

Introduction

Over 18 000 Australian women will be newly diagnosed with invasive breast cancer in 2018[1] and approximately 40% will undergo mastectomy.[2] Breast reconstruction (BR) has long been recognized as a means of supporting recovery from the psychological and emotional trauma of mastectomy, enhancing body image and improving quality of life.[3–6] Many guidelines globally now recommended BR for all women undergoing mastectomy as part of their breast cancer treatment.[7–13]

BR can be performed at the same time as mastectomy – immediate BR (IBR) or performed after mastectomy in a separate procedure – delayed BR (DBR). The importance of discussing all BR options is reflected in the recent Cancer Australia best practice statement, emphasizing that it is 'not appropriate to perform a mastectomy without first discussing with the patient the options of

immediate or delayed breast reconstruction'.[2] In the interests of equity, all women should have informed discussions prior to mastectomy, as well as support to pursue BR if that is their choice.

The existing studies on BR mainly focus on IBR as estimating DBR rates is complicated by the lag time between mastectomy and reconstruction. Contemporary, surgeon-notified data on Australian IBR estimated rate of 18%,[14] lower than the rate in the USA (26%)[15] and UK (23%).[16] Variability in IBR rate by patient sociodemographic and clinical characteristics, surgeon caseload and treatment centre settings has been reported in Australia.[17–21] To date, no Australian studies have examined variation in IBR rates between all hospitals within a particular jurisdiction, despite international data suggesting that hospital is an important contributor to variation in IBR rates.[22]

This research is the first population-based analysis of inter-hospital variation in IBR rates and the relative contribution of patient residential neighbourhoods and hospitals to IBR utilization in New South Wales (NSW), Australia's most populous state. It is thus uniquely positioned to provide new insights into potential enablers and barriers to IBR uptake.

Methods

Data and setting

We used data from the NSW Admitted Patient Data Collection (APDC) in the period 1 January 2012 to 30 June 2015. The APDC records all surgical procedures in all NSW hospitals and health service facilities. Inpatient care in NSW is delivered in 225 public hospitals and 203 private hospitals;[23] patients may choose to be treated as a public patient in a public hospital, or as a private patient in a public or private hospital. The APDC records include the following information: patient age and gender; private health insurance status; place of residence mapped to the Australian Bureau of Statistics' 2011 statistical areas level 2 (SA2);[24] details about the admission (diagnosis and procedure codes); and hospital information (unique identifier and hospital type).

Study population

We extracted the records for all women diagnosed with invasive breast cancer or ductal carcinoma *in situ* who had undergone a therapeutic mastectomy in a NSW hospital based on the diagnosis and procedure codes (Table S1), as illustrated in Figure S1. We considered women to have undergone IBR if they had undergone a mastectomy as well as BR on the same date.

Explanatory variables

Patient-level variables included age group, country of birth, private health insurance status and residential neighbourhood at the time of mastectomy. Patient residential neighbourhood-level factors included socioeconomic status (SES) and remoteness. We classified the SES according to the Index of Relative Socio-economic Advantage and Disadvantage.[25] We grouped the Index of Relative Socio-economic Advantage and Disadvantage deciles according to the most disadvantaged (deciles 1–3), middle SES (deciles 4–7) and most advantaged (deciles 8–10).[25,26] We also mapped residential neighbourhood to the Australian Statistical Geography Standard for Remoteness Area (major cities versus regional/remote areas, formed by collapsing the inner and outer regional, remote and very remote areas into one category[27]).

Hospital-level factors included hospital type (public or private), hospital location (metropolitan if located within NSW metropolitan Local Health Districts, or non-metropolitan if otherwise) and volume of mastectomies, based on the total number of mastectomies performed during the 42-month observation period (low <122.5, average 122.5–315, high >315).[26,28]

Statistical analysis

We calculated crude IBR rates overall, by patient-, neighbourhood- and hospital-level factors, and derived adjusted mean IBR rates using cross-classified random-effects logistic models. We selected this method due to the data structure, in which each patient could potentially belong to any combination of neighbourhood and treating hospital, forming a two-way cross-classification. This method allowed us to quantify the variation in IBR between neighbourhoods and hospitals, and to assess their relative contribution to IBR variation.

We built a sequence of models by adding patient-, neighbourhood- and hospital-level factors in a step-wise manner, with the final model adjusting for all covariates. As patient private health insurance status was highly collinear with hospital type (correlation coefficient 0.8695), we included hospital type only in the final adjusted model due to our focus on inter-hospital variation in IBR rates. While the majority (88%) of women residing in metropolitan neighbourhoods underwent mastectomy in metropolitan hospitals, only 75% of women residing in non-metropolitan neighbourhoods underwent mastectomy in non-metropolitan hospitals. We, therefore, created a combination variable by patients' residential neighbourhoods and treating hospital locations for use in the final fully adjusted model.

We derived the adjusted IBR rates and IBR odds ratios by varying the covariates of interest while setting the rest of the covariates at their mean value in the final model. We used intra-class correlation coefficient (ICC) statistics[29,30] to measure the relative contribution of patients' residential neighbourhoods and treating hospitals to the probability of women having IBR: the higher the ICC, the more important the context is. We also undertook a supplementary analysis of DBRs performed during the study period by allowing for a 2-year interval between mastectomy and DBR.

We estimated the models in the MLwiN 3.01 software (University of Bristol, Bristol, UK).[31] We used *P*-value at 0.05 for statistical significance testing and presented model estimates with 95% Bayesian credible intervals (CrIs).

The study was approved by the NSW Population Health Service Research Ethics Committee, Cancer Institute NSW, Australia.

Results

We identified 7961 women who underwent therapeutic mastectomy at 100 NSW hospitals (55 public and 45 private); 6530 (82%)

women had unilateral mastectomy and the remainder had bilateral mastectomy. The majority of women were 50 years or over (77%) and born in a western country (84%); 57% had private health insurance; 73% resided in metropolitan areas and 74% were from the least disadvantaged neighbourhoods. The number of mastectomies performed was split equally between private and public facilities, while IBR was predominantly performed in the private sector; 71% of IBR were in metropolitan hospitals and 27% in low-volume hospitals (Table 1). Of the women from regional/remote areas who had their mastectomy in metropolitan hospitals, approximately 49.6% were undertaken in private hospitals.

In the fully adjusted model, we found that women of older age, those born in Asian countries (as opposed to in western countries) or living in a lower SES neighbourhood were significantly less likely to undergo IBR (Table 2, Fig. 1). Women born in Asian countries had a significantly lower IBR rate than those born in western countries (12% versus 18%; odds ratio 0.5, CrI 0.4–0.6). Women attending public or low-volume hospitals were significantly less likely to undergo IBR than those attending private or average volume hospitals, respectively. Women living in the regional/remote areas undergoing mastectomy at metropolitan hospitals were twice as likely to have IBR, compared with their metropolitan-residing counterparts who also had their mastectomies performed in metropolitan hospitals (referent group). In contrast, women living in the regional/remote areas undergoing mastectomy at non-metropolitan hospitals were significantly less likely to have IBR than the referent group. The estimated adjusted IBR rates for women from the regional/remote areas undertaking IBR in metropolitan and non-metropolitan hospitals were 27.9% and 10.0%, respectively.

Table 1 Patient-, residential neighbourhood- and hospital-level characteristics and crude immediate breast reconstruction (IBR) rates among women undergoing therapeutic mastectomy in New South Wales (1 January 2012 to 30 June 2015)

	Therapeutic mastectomy		IBR	
	n	%	*n*	Crude rate (%)
	7961		1518	19.1
Patient-level demographic characteristics				
Age group at admission date (years)				
<40	418	5	187	44.7
40–49	1427	18	518	36.3
50–59	1897	24	512	27.0
60–69	1943	24	238	12.2
≥70	2276	29	63	2.8
Country of birth				
Western	6680	84	1244	18.6
Asia	934	12	185	19.8
Africa and Middle East	347	4	89	25.6
Private health insurance				
Yes	4505	57	1050	23.3
No	3456	43	468	13.5
Patient residential neighbourhood-level characteristics				
Remoteness				
Major cities	5797	73	1277	22.0
Regional/remote	2164	27	241	11.1
SES				
Most advantaged	3089	39	885	28.7
Middle SES	2810	35	420	14.9
Most disadvantage	2062	26	213	10.3
Hospital-level characteristics (*n* = number of hospitals)				
Hospital type				
Private (*n* = 45)	4002	50	936	23.4
Public (*n* = 55)	3959	50	582	14.7
Hospital location				
Metropolitan (*n* = 56)	5627	71	1353	24.0
Non-Metropolitan (*n* = 44)	2334	29	165	7.1
Volume				
High (*n* = 10)	2897	36	732	25.3
Average (*n* = 23)	2921	37	575	19.7
Low (*n* = 67)	2143	27	211	9.8
Patient residential neighbourhood and hospital location				
Major cities–metro hospital	5081	64	1227	24.1
Major cities–non-metro hospital	716	9	50	7.0
Regional/remote–metro hospital	546	7	126	23.1
Regional/remote–non-metro hospital	1618	20	115	7.1

SES, socioeconomic status.

The mean IBR rate across the 100 hospitals in NSW performing mastectomy was 17.1% (95% CrI 12.1%–23.1%), but substantial variation existed between hospitals. The probability of women having IBR in 21 hospitals was significantly higher than this state-wide average rate and significantly lower in seven hospitals. The inter-hospital variance in IBR rates (variance 4.337, CrI 2.634–6.889) was much larger than the inter-neighbourhood variance (variance 0.024, CrI 0.001–0.091). The hospital-level ICC was calculated to be 56.7%, suggesting that more than half of the unexplained IBR variation was attributable to other unmeasured or unobservable differences between hospitals. It was much larger than the neighbourhood-level ICC (0.3%), indicating that hospitals played a much more important role in women's likelihood of having IBR than neighbourhoods. The overall crude IBR rate was 3% for autologous IBR (n = 235); 15% for implant-based IBR (n = 1198) and 1.1% for combined implant and autologous surgery (n = 85).

Finally, we identified 2999 women between 1 January 2012 and 30 June 2013 underwent DBR within 2 years of mastectomy. We calculated a crude DBR rate of 5.6% with a median interval of 461 days (approximately 15 months) between mastectomy and DBR. This rate, however, is likely to be underestimated due to the short 2-year follow-up time available.

Discussion

This study revealed that wide inter-hospital variation exists in IBR rates within NSW and investigated the underlying drivers for such variation. Older women, those born in Asian countries, patients residing in lower SES neighbourhoods or undergoing surgery in public hospitals were significantly less likely to have IBR. These findings are consistent with findings from many previous Australian and international studies.[14,17–21,26,32,33]

The overall crude IBR rate in NSW was 19.1%, similar to a previous estimate of 18% using the Breast Surgeons of Australia and New Zealand's Quality Audit data.[17] But our study additionally revealed the importance of hospitals in influencing IBR, as found in many international studies.[22] A recent systematic review identified Australian health system limitations, such as cost, waiting times, unavailability of BR service in local areas and a shortage of

Table 2 Adjusted mean immediate breast reconstruction (IBR) rates and odds ratios of IBR by patient-, residential neighbourhood- and hospital-level characteristics in New South Wales between 1 January 2012 and 30 June 2015

	Adjusted mean IBR rate (%)	Adjusted OR	2.5% Bayesian CrI	97.5% Bayesian CrI	*P*-value
Patient-level demographic characteristics					
Age group at admission date (years)					
<40	38.3	37.5	26.6	53.6	<0.001
40–49	33.3	26.0	19.5	35.2	<0.001
50–59	27.3	16.4	12.4	22.0	<0.001
60–69	16.2	5.7	4.3	7.8	<0.001
≥70	5.4	1.0	Reference		
Country of birth					
Western	18.0	1.0	Reference		
Asia	12.0	0.5	0.4	0.6	<0.001
Africa and Middle East	18.1	1.0	0.7	1.4	0.484
Patient residential neighbourhood-level characteristics					
SES					
Most advantaged	19.3	1.0	Reference		
Middle SES	16.9	0.8	0.7	0.9	0.005
Most disadvantaged	15.4	0.7	0.5	0.8	<0.001
Hospital-level characteristics					
Hospital type					
Private	22.4	1.0	Reference		
Public	13.4	0.4	0.1	1.0	0.026
Volume					
High	20.1	2.8	0.7	13.0	0.084
Average	20.9	3.3	1.1	10.7	0.018
Low	11.0	1.0	Reference		
Patient residential neighbourhood and hospital location					
Major cities–metro hospital	20.1	1.0	Reference		
Major cities–non-metro hospital	13.4	0.5	0.1	1.5	0.088
Regional/remote–metro hospital	27.9	2.0	1.5	2.7	<0.001
Regional/remote–non-metro hospital	10.0	0.3	0.1	0.8	0.007

CrI, credible interval; OR, odds ratio; SES, socioeconomic status.

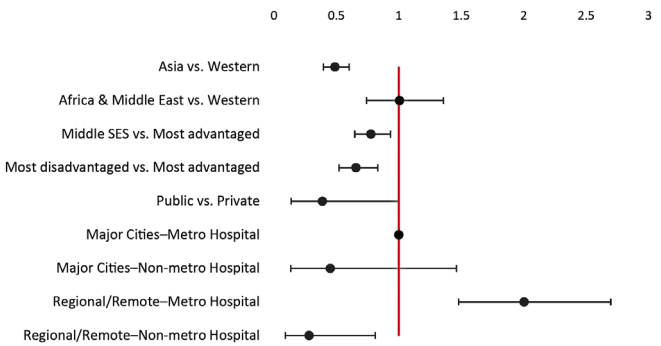

Fig. 1. Forest plot of adjusted odds ratios (ORs) of immediate breast reconstruction by country of birth, residential neighbourhood-socioeconomic status, hospital type and neighbourhood-hospital locations. (●), Adjusted OR; (——) OR = 1.

hospital facilities as barriers to uptake of BR.[34] In our cohort, around 12% of women with private health insurance chose to have their IBR in a public hospital, possibly to avoid the considerable out-of-pocket costs. Roder and colleagues suggested that not providing IBR options to patients, inaccessibility to speciality services and/or a lack of surgical expertise in smaller centres may be among the reasons for low IBR rates.[20] Our results support these findings of unmet demand for IBR in the regional/remote areas: a quarter of women living in these regional/remote areas chose to travel to metropolitan hospitals for mastectomy and they were significantly more likely to undergo IBR than their metropolitan counterparts.

Some existing studies suggested that hospitals and/or surgeons act as gatekeepers to BR access[16,35–37] and that inter-hospital variations may not be 'purely resource-driven'.[17] In NSW, surgeons must be accredited by a hospital in order to be granted operating privileges and lists at that particular hospital. The individual surgeons then determine what kind of surgery they perform at that hospital as long as it is within the scope of practice of their appointment. It is logical then that hospitals who employ more surgeons who perform IBR will have higher rates. A systematic review indicated that up to 50% of women would choose to have BR following therapeutic mastectomy if given that option,[38] while simply being informed about IBR option increased patients' odds of having IBR by 14-fold.[39] The importance of breast surgeons' gatekeeper role has also been demonstrated in studies from the USA,[35] Sweden[36] and England.[16,37]

Policy implications

The current study provided baseline evidence to further our understanding of the drivers for inequitable access to IBR services. Given our observed lower IBR uptake in the disadvantaged population and the potential negative consequences for women who would like to access IBR following mastectomy but cannot, it is imperative to identify, quantify and address these underlying causes of variation. These findings can guide policy-makers' decisions about appropriate resource allocation, such as preferred locations for BR centres of excellence, hospital and workforce planning and surgical

accreditation, and necessary support for patients' easier access to these resources.

In addition, women with breast cancer, general practitioners (GPs) and surgeons should be supported through educational programmes to improve their awareness of the benefits of BR and the importance of discussing options prior to mastectomy, as also recommended by the Breast Cancer Network Australia 2011 report.[40] Designated referral pathways should be established between breast cancer screening centres, GPs and surgeons to ensure a more efficient transfer of patients who wish to consider IBR to breast specialist centres that offer it. This approach may help to address the 'postcode lottery' situation and provide women interested in discussing IBR with the option.

Strengths and limitations

This is the most comprehensive Australian analysis of IBR utilization patterns through a population-based study. The NSW hospitalization data have been demonstrated to have high sensitivity and specificity in identifying patients with breast cancer when validated against cancer registry data.[41] However, we acknowledge the potential for miscoding within administrative datasets. We could not consider cancer stage, tumour size and patient comorbidities or risk factors. However, several studies have previously found that differences in patient characteristics, comorbidities or tumour characteristics did not explain regional differences in IBR rates.[22,36,37,42] Other limitations include a lack of data on individual surgeon volume, reconstructive model (one or more surgeons performing IBR on the same patient), patient and surgeon preferences and the complexities of their decision-making in the surgical treatment of breast cancer, which cannot be adequately ascertained using administrative data. This study focused on IBR due to the longer-term required for DBR.[14] Future research using a longitudinal series of APDC would enable comparison of DBR patterns against the current IBR analysis.

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Conflicts of interest

AGE receives salary support as the HCF Research Foundation Professorial Research Fellow, is a Ministerial appointee to the (Australian) Medicare Benefits Schedule (MBS) Review Taskforce, is a Board Member of the NSW Bureau of Health Information, consults to Cancer Australia including their 'statements' initiative and sits on the Cancer Council Australia Health Services Advisory Committee. KF and AS receive funding for their research from the Friends of the Mater Foundation, Mater Hospital, North Sydney.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Diagnosis code and procedure codes used to identify the study cohort.
Figure S1. Cohort selection flow chart.